appendix **ten**

Sample Quality Assurance Plan

for reference only

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10.1 Background

Commitment to quality, statement, policy, and objectives

This section ties together the quality policies and objectives of SFMTA, the consultant team, and the Contractor, as required to deliver a quality project.

SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY
Commitment to Quality Statement

"Quality and safety are clearly the highest priority matters on any SFMTA Project. Quality is the result of high standards, intelligent application, diligent effort, and disciplined execution. This can only be achieved through the proactive application of quality principles in all aspects of the project, from conceptual thinking to detailed design to construction execution. Quality is not just a management responsibility; it is everyone's responsibility within the organization. Each and every one of us is individually responsible for improving the product of our own work efforts and doing what we can to improve the products of our co-workers. SFMTA commits to deliver the highest quality products in a cost effective manner."

Quality Policy

The SFMTA's mission to provide superior services to its customers and to provide the safest and most productive work place for its employees requires that SFMTA develop and procure products and services of the highest *quality and reliability,* and in strict conformance with applicable specifications, procedures, and regulations. It is the responsibility of all employees, contractors, suppliers, subcontractors, consultants, and sub-consultants supporting the development, contracting, and/or procurement of the Muni Radio System Replacement (MRSR) Project to comply with the quality management program and perform their responsibilities in a manner that will enhance SFMTA's ability to develop and implement this project, and to conduct themselves to the highest professional standards.

Quality Objectives

The Quality Program objectives for the Muni Radio System Replacement (MRSR) Project Quality Assurance Plan (QAP) are to:

- Implement a comprehensive, integrated quality program to achieve compliance with contractual requirements and statutory regulations with regard to performance, safety, and reliability; and
- Implement a Quality Program consistent with the SFMTA Quality Assurance Plan and meet the intent of the requirements described in the Federal Transit Administration Quality Assurance and Quality Control Guidelines (FTA-IT-90-5001-02.1).

Booz Allen Team

The consultant team lead by Booz Allen Hamilton (Booz Allen Team) hereby adopts SFMTA's quality policy and objectives for the duration of the Muni Radio System Replacement (MRSR) project. This document incorporates the Booz Allen Team's quality assurance program for the MRSR Project.

Quality Policy

Booz Allen Hamilton, Inc. is one of the leading international management and technology consulting firms in the world and is committed to helping management solve complex problems. This commitment has shaped the firm's values and professional practices since its founding in 1914.

Booz Allen Hamilton's policy is to provide the highest quality consulting services to meet client contractual obligations and differentiate us from our competitors. Client service is governed by the principles established in the two primary documents that state the firm's policies and practices on professional ethics and conduct:

- "Statement of Professional Values, Policies, and Practices" (The Green Book)
- "Statement of Ethics and Conduct for Government Business" (The Blue Book).

Each employee is expected to know and observe the policies, practices, and procedures presented in these two documents, especially those related to the quality of our work. In addition, Booz Allen staff and subconsultants who are working on the MRSR Project will be trained and are expected to comply with the quality policies and procedures in this plan.

CONTRACTOR - *TBD*

Quality Commitment Statement To be inserted after selection of the Contractor

10.2 General

Introduction

The Muni Radio System Replacement (MRSR) Project consists of four contract phases:

- **Phase 1** – Project Development and Conceptual Engineering
- **Phase 2** - Preliminary Design and Procurement Contract Document Preparation/Development
- **Phase 3** - Radio System Vendor Selection
- **Phase 4** - Radio System Final Design and Implementation/Construction.

The Booz Allen Team is currently contracted to work on Contract Phases 1 and 2. While this document is written with the understanding that Booz Allen will continue to support the SFMTA in Phases 3 and 4, SFMTA has the option proceed without said support, as result of factors such as availability of funding and the decision to proceed with the subsequent phases of the project.

The replacement system(s) to be specified in Contract Phases 1 and 2 and procured in Contract Phases 3 and 4 will include, but are not limited to, the following:

- Mobile and handheld radios, mobile data terminals, base stations, site upgrades and/or construction, radio antenna tower replacements and/or construction
- Backbone network, network management consoles, radio network controllers
- Administrative, test, telemetry monitoring, and support sub-systems
- Computer-Aided Dispatch (CAD) System and consoles
- Voice Recording and Retrieval System for Radio and Telephone Systems
- Subway radio coverage distribution system
- Communications interoperability with the Department of Emergency Management (DEM) radio system
- Integrated Automatic Vehicle Location (AVL) System
- Radio System Supervisory Control and Data Acquisition (SCADA).
- Interface to telephone system
- Interface to SFMTA's Existing Public Address (PA) Systems, and other enterprise communications, software application, and database systems
- Interfaces from new mobile radios to vehicle on-board power, control, and communications systems
- Redundant (back-up) radio system communications center
- High bandwidth short-range vehicle-to-wayside bi-directional wireless data communications
- Expandability to include the new Central Subway infrastructure.

Purpose

This MRSR QAP is the principal document overseeing the quality for the management, planning, engineering, design, procurement, and design/build activities of the MRSR Project. The QAP identifies project-relevant quality practices and resources.

The QAP follows the requirements of Federal Transit Administration (FTA) Quality Assurance and Quality Control (QA/QC) Guidelines, FTA-IT-90-5001-02.1 dated February 2002, and SFMTA's Quality Assurance Program. It is highly recommended that all employees, suppliers, subcontractors, and consultants supporting this project, read the FTA QA/QC Guidelines document to understand the history and rationale for the development of this QAP.

The QAP is a "living" document and will be revised and updated as needed. All users are encouraged to bring changes or suggestions for improvement to the Booz Allen Team for review and approval. If approved, changes will be forwarded to the SFMTA Project QA Manager for acceptance.

The QAP demonstrates that SFMTA's and Booz Allen Team's management have established the quality policy and a system of quality procedures to accomplish the quality objectives. The SFMTA and the Booz Allen Team will have assigned duties, delegated authority, and set up suitable testing, inspection, examination, surveillance, and audit programs to verify that required performance standards have been met. The MRSR QAP, quality procedures, project-specific procedures and work instructions comprise a comprehensive "stand-alone" Quality Program.

Scope

The QAP scope currently covers the Booz Allen Team's activities for contract Phases 1, 2, 3 and 4 including, but not limited to: general tasks; systems integration; intra-discipline and inter-discipline review; design workshops; preliminary and conceptual design; final design and contract documents; design review process; design support during implementation/construction; procurement; cut-over and startup operations; and design/build management, i.e. inspections, testing, document reviews, handling of non-conformances and managing of corrective actions.

The Booz Allen QA Team is tasked with "day-to-day" quality assurance functions. These functions are assigned to the Project Quality Manager, Quality Engineers and others as required throughout the duration of the project. Quality assurance functions which express SFMTA's responsibilities will remain with the SFMTA Project QA Manager and SFMTA Quality Assurance Manager.

The SFMTA Project Engineer, the Booz Allen Design Manager, and the Contractor's quality staff will be tasked with the quality control functions throughout the different phases of the project.

The QAP scope applies to all personnel assigned to the project, as identified within the QAP.

As described within this QAP, all members of the Booz Allen Team are required to comply with the quality plan requirements consistent with their scope of work.

Once the Contractor has been selected in Phase 3, the Contractor's quality scope will be incorporated into this document, and may be supplemented by the Contractor's other Quality Program components.

Objectives

The objectives of this QAP are to:

- Demonstrate the commitment by the entire project team, to the Quality Policies set forth by SFMTA
- Demonstrate that the Quality Program meets the intent of the FTA QA/QC Guidelines and the SFMTA Quality Program requirements
- Describe and document the QAP, indicating the responsibilities and interrelated activities for implementing the Quality Program in accordance with requirements, procedures, standards and statutory regulations.
- Provide the basis for auditing, reviewing, and evaluating the management of quality and ensuring the effectiveness of the QAP for the MRSR Project.

Source Documents

The source documents for the QAP are the following:

- Booz Allen Hamilton's contract documents
- SFMTA Transportation Planning and Development Division's Quality Assurance Plan
- FTA QA/QC Guidelines.

Control Of The Project Quality Assurance Plan

The QAP has been prepared by the Booz Allen Team's Project Quality Manager and forwarded to the SFMTA Quality Assurance Manager and SFMTA Project QA Manager for review and approval. After approval by the SFMTA Quality Assurance Manager and SFMTA Project QA Manager, the QAP will be formally issued as a supplement to the MRSR Project Management Plan.

Definition of Terms

Unless specified to the contrary, all quality terms in this QAP shall have the meanings described in ISO 8402: 1994, Quality—Vocabulary, and include the following:

Term	Definition
Booz Allen Team	**The Consultant (and its subconsultants) contracted by SFMTA for the MRSR Project to perform on the Professional Engineering Services for Radio System Replacement project CS-139.**
Company/Purchaser/ Owner	**San Francisco Municipal Transportation Agency (SFMTA)**
Contractor	**Organization selected to perform final design and implementation in Phase 4.**
Corrective Action	**An action taken to eliminate an existing nonconformity, defect, or other undesirable situation.**
Design Manager	**The Design Manager for Phases 1 and 2 is part of the Booz Allen Team and responsible for the conceptual and preliminary design of the MRSR Project.**
Design/Build	**MRSR Project phase 4 implementation**
Engineer-of-Record	**The Engineer-of-Record for the 35% design is a member of the Booz Allen Team. The Engineer-of-Record responsible for Final Design will be a part of the Contractor's Design/Build Team.**
Organization	**Company, corporation, firm, enterprise, or institution, or part thereof that has its own functions and administration.**
Preventive Action	**An action taken to eliminate the cause(s) of an existing or potential nonconformity, defect, or other undesirable situations, in order to prevent occurrence.**
Procedure	**A description of processes and method(s) used to meet quality requirements, and specifying how functional organizations interrelate to accomplish these requirements.**
Product	**The result of an activity or a process such as tangible (e.g., processed materials or assemblies) or intangible (e.g., knowledge), intended (e.g., offering to customers) or unintended (e.g., pollutants).**
Project Quality Manager	**Booz Allen Team Quality Manager**
Project Team	**All organizations involved in delivering the MRSR Project, including the SFMTA, the Booz Allen Team and the Design/Build Contractor.**

Term	Definition
Quality	Totality of characteristics of an entity that bear on its ability to conform to requirements.
Quality Assurance	All those planned and systematic actions necessary to provide adequate confidence to SFMTA management and the Booz Allen Team that a product or service will satisfy given requirements for quality. QA emphasizes "upstream" actions that directly improve the chances that QC actions will result in a product or service that conforms to requirements. QA includes making sure that the project requirements are developed to meet the expectations of all relevant internal and external agencies, planning the processes needed to assure quality of the project, ensuring that the equipment and staffing is capable of performing tasks related to project quality, ensuring that contractors are capable of meeting and do carry out quality requirements, and documenting the quality efforts.
Quality Assurance Audit (Quality Audits)	A documented activity performed in accordance with written procedures or check lists to verify, by examination and evaluation of objective evidence, that applicable elements of the Quality Management Program have been developed, documented and effectively implemented in accordance with specified requirements. A quality audit should not be confused with surveillance or inspection.
Quality Assurance Plan	A collection of written descriptions of intended actions to control and assure quality on this MRSR Project. As part of the Quality Program, the Quality Assurance Plan (QAP) defines the quality policy for the MRSR Project and quality procedures and project-specific procedures.
Quality Control	"The operational techniques and activities that are used to fulfill requirements for quality." These techniques are used to validate that a product, process or service meets requirements. QC is carried out by the operating forces, their job is to perform the work in accordance with requirements and procedures and meet the product or service goals. Generally, QC refers to the act of taking measurements, testing, and inspecting a process or product to confirm that it meets requirements. It also includes actions by those performing the work to control the quality of the work. Products may be design drawings or specifications, manufactured equipment, or constructed items. QC also refers to the process of documenting such actions. QC is a production tool.
Quality Control Manager	The QC Manager for Phase 4 will be on the Contractor's Design/Build Team and is responsible for monitoring the implementation of the Contractor's Quality Program by performing product identification and traceability, process control, handling of nonconformances and corrective actions, inspection and testing.
Quality Management Program (agency-level)	An agency wide program, endorsed by Executive Management, developed to assure quality in all aspects of its work.

Term	Definition
Quality Policy	The overall quality intentions and direction of an organization regarding quality, as formally expressed by management.
Quality Program (project-level)	Organizational structure, procedures, processes and resources needed to implement quality management for the MRSR Project.
SFMTA Project QA Manager	SFMTA Quality Assurance Manager assigned to the MRSR Project.
SFMTA Quality Assurance Manager	SFMTA Quality Assurance Manager, member of the SFMTA Quality Assurance Office responsible for agency-wide QA/QC.
Subconsultant	Organization that provides services to the prime Consultant.
Subcontractor	Organization that provides a product or services to the Prime Contractor.
Surveillance	Monitoring or observing an item or event to determine whether it conforms to specified requirements.
Validation	Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.

ACRONYMS

SQ	American Society of Quality
CQA	Certified Quality Auditor
CAR	Corrective Action Report
COTS	Commercial off the shelf
DRR	Document Review Record
EOR	Engineer of Record
FTA	Federal Transit Administration
IDRI	nspector Daily Report
Inspector	Design/Build Contractor Inspector
MRSR	Muni Radio System Replacement project
SFMTA	San Francisco Municipal Transportation Agency
NCR	Nonconformance Report
PDCC	Project Document Control Center
PM	Project Manager
PPM	Project Procedures Manual
QAF	Quality Assurance Finding
QAP	Project Quality Assurance Plan
QA/QC	Quality Assurance/Quality Control

Quality Elements

FTA guidance requires that Quality Programs include the 15 elements adopted by the American National Standards Institute for Quality Programs (ANSI/ASQ A90-Q94). These 15 quality elements provide the underpinning of the QAP. They include:

- Management responsibility
- Documented Quality Program
- Design control
- Document control
- Purchasing
- Product identification and traceability
- Process control
- Inspection and testing
- Inspection, measuring, and test equipment
- Inspection and test status
- Nonconformance
- Corrective action
- Quality records
- Quality audits
- Training.

The MRSR QAP will address each of the 15 FTA quality elements, and will be further supported by the Project Procedures Manual (PPM). The PPM is a document issued separate from this QAP. The PPM is a "living" document and will be revised and updated as needed. All users are encouraged to bring changes or suggestions for improvement to the SFMTA or the Booz Allen Team for review and approval. If approved, changes will be forwarded to the SFMTA Project QA Manager for acceptance.

Any revisions to the procedures will be approved by the applicable manager and tracked in Project Procedures Index and Revision Records for that procedure. Not all procedures have been identified in this QAP. Project Team members shall refer to the latest PPM for a full and most current index procedures.

Management Responsibility

SFMTA

SFMTA has developed a project management-based organization structure to manage the MRSR Project. The management responsibility for the MRSR Project is the primary responsibility of the SFMTA Project Manager, who has overall responsibility for completing the MRSR Project within budget, on schedule and within the scope.

The SFMTA QA Office has overall responsibility for the SFMTA Quality Management Program, while the SFMTA Quality Assurance Manager is responsible for managing and coordinating the development, implementation and continuous evaluation of the SFMTA Quality Management Program.

The SFMTA Project QA Manager is assigned the responsibility for implementation and management of the Quality Management Program for the MRSR Project, and is responsible for development, implementation and continuous evaluation of the MRSR QAP.

Booz Allen Team

The Booz Allen Team has overall responsibility for fulfilling their contract requirements and delivering high quality products and services. The officers of Booz Allen Hamilton are responsible for the overall quality of Booz Allen Team work. The Officer-In-Charge (OIC) of the MRSR Project ensures that the firm's resources are available to the Project Managers and that the project is executed such that value and quality is delivered to the client.

The Booz Allen Team's Project Manager (PM) is responsible for achieving a mutual understanding of project objectives with the client, managing the work to the highest possible standards, meeting budget and schedule objectives, managing sub-consultants, conducting meetings and submitting invoices in a timely manner.

For this conceptual and preliminary engineering phase, a Booz Allen Team Design Manager has been appointed by the PM. The Design Manager will be responsible for the conceptual and preliminary design of the MRSR system, and will provide engineering support during the construction phase of the project. All team members are directed to apply quality procedures during the project; strive for accuracy of design and, analysis, and robustness of recommendations; working within the specified budget and schedule.

The Booz Allen Team will provide the Project Quality Manager to work as directed by, or in conjunction with, SFMTA quality managers towards the goal of delivering the MRSR Project to the standards established by the Quality Management Program.

Organization

The MRSR Project is structured such that:

- Quality is maintained by those who have been assigned responsibility for performing the work.
- Quality achievement is verified by persons or organizations not directly responsible for performing the work.
- The organization responsible for quality will have sufficient authority, access to work areas, and organizational freedom to identify quality problems; verify implementation of solutions; and assure that further processing, delivery, or installation is controlled until proper correction of a deficiency, nonconformance or unsatisfactory condition has occurred.
- Quality verification functions will report to a level of management which provides sufficient authority and organizational freedom to assure that appropriate action is taken to resolve conditions adverse to quality.

The MRSR Project Quality Team Organization Chart depicting the reporting relationships of those responsible for Quality Assurance and Quality Control to the SFMTA and corporate management is provided in Figure 1 on the following page.

Responsibilities for Quality

The responsibility and necessary authority for implementing the MRSR QAP has been delegated to the following quality roles:

SFMTA Quality Assurance Manager

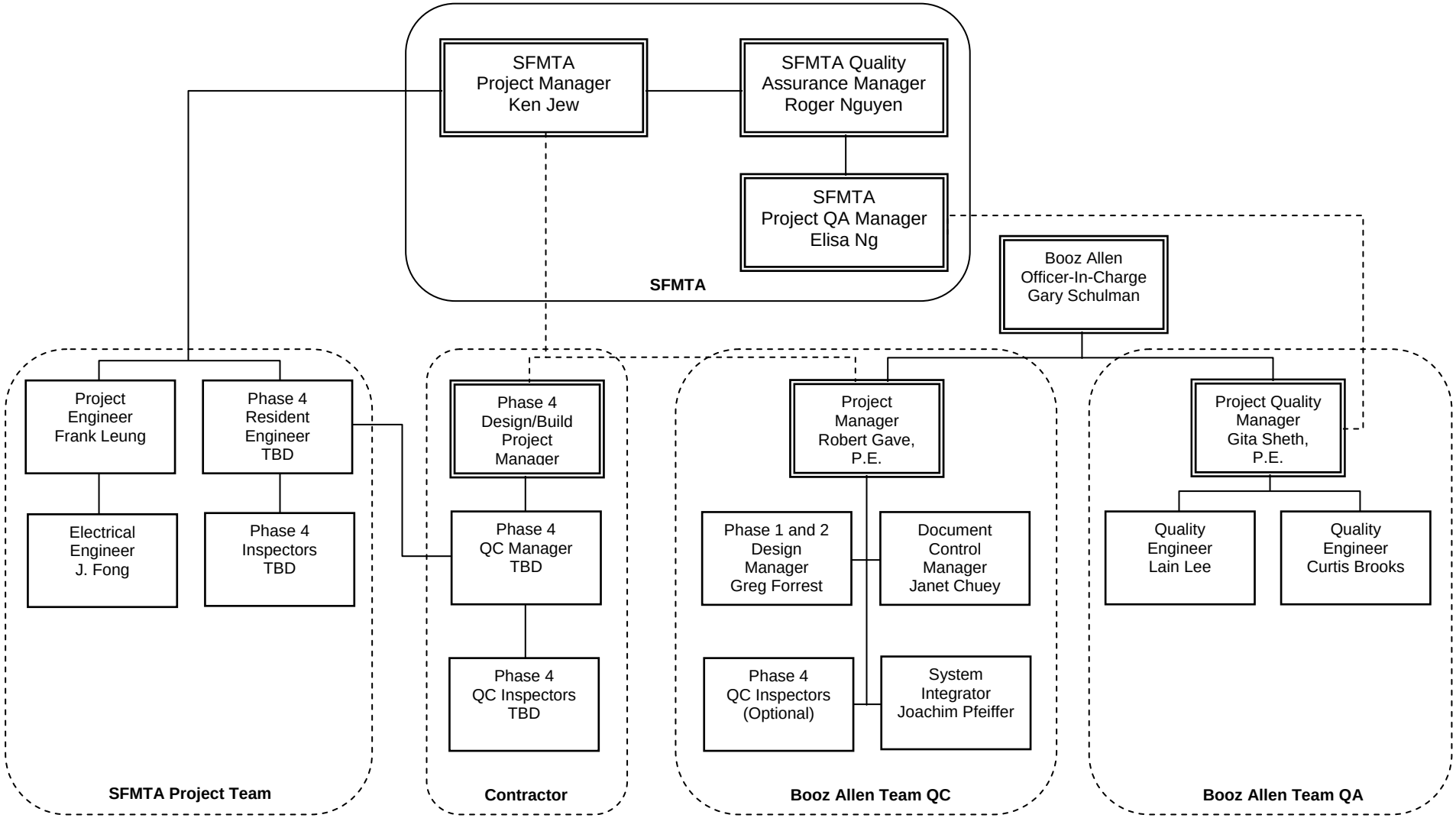
The SFMTA Quality Assurance (QA) Manager is ultimately responsible for the quality of the MRSR Project. The SFMTA Quality Assurance Manager functions independently from the project team, reports directly to the SFMTA Senior Director. The SFMTA QA Manager is responsible for managing and coordinating the development, implementation and continuous evaluation of the Quality Management Program.

The SFMTA QA Manager is delegated the authority and organizational freedom to identify and evaluate quality problems; to initiate, recommend or provide solutions; and to control further processing, delivery or installation of nonconforming or deficient items. The SFMTA QA Manager will notify the SFMTA Project Manager of any stop order recommendations initiated by either himself or the SFMTA Project QA Manager. If necessary to stop work, the SFMTA Quality Assurance Manager will recommend to the SFMTA Senior Director to have a stop work action issued to the consultant, contractor, and/or a project team. An order of stop work can only be removed after the resolution of the quality issue(s) have been obtained, reviewed and approved by the SFMTA Quality Assurance Manager. If the matter is not resolved, the SFMTA QA Manager will elevate the issue back to the SFMTA Senior Director for final action.

The SFMTA Quality Assurance Manager is responsible for evaluating compliance to established quality requirements and reporting results to the SFMTA Senior Director. The SFMTA Quality Assurance Manager is responsible for reviewing and performing process and product audits including: program and procedure compliance of design activities, procured items and services, design/build inspection program, design/build testing, and systems integration testing to confirm compliance with contract documents and/or controlling procedures.

Audit and surveillance reports are provided to the SFMTA Senior Director, appropriate managers, the Design Manager, the Engineer-of-Record, the Resident Engineer, and the

Figure 1: MRSR Quality Team Organization Chart



audited/surveyed organization to inform of the program effectiveness and to identify conditions requiring corrective action. Audit and surveillance reports are tracked and status reports will be provided on a monthly basis to management to assure that corrective actions are implemented.

Technical specialists may be utilized under the direction of the SFMTA Quality Assurance Manager, to independently review/assess technical adequacy and acceptance of specialized products being audited.

SFMTA Project QA Manager

The SFMTA Project QA Manager is assigned the responsibility for overseeing the implementation and the management of the Quality Management Program, by the Booz Allen Team, for the MRSR Project. The SFMTA Project QA Manager reports to the SFMTA Quality Assurance Manager.

These responsibilities include overseeing that the MRSR Quality Program is established, implemented and maintained, and that reporting of the performance of the Quality Program to management is in place by the Booz Allen QA Team.

The SFMTA Project QA Manager is delegated the authority and organizational freedom to identify and evaluate quality problems; to initiate, recommend or provide solutions; and to control further processing, delivery or installation of nonconforming or deficient items. When there is a potential to stop work, the SFMTA Project QA Manager will recommend to the SFMTA QA Manager to have a stop work action issued to the consultant or contractor. If in agreement, the SFMTA QA Manager will notify and discuss the issue with the SFMTA Project Manager for action and resolution describe in Section 3.1.4.1.

Specific activities include the following:

- Identify project quality requirements.
- Support interface and coordination for quality reviews, surveillances, or audits of the Quality Program by the SFMTA or other external auditors.
- Participate in quarterly MRSR Project quality management review meetings.
- Keep the SFMTA Quality Assurance Manager informed regarding project quality matters
- Act as the liaison for SFMTA quality requirements to FTA.
- Verify that the project Quality Program is effectively implemented and maintained through reviews and approvals of the Project Quality Manager's activities, including quality audits, surveillances, and quality management reviews.

Booz Allen Team Project Quality Manager

Booz Allen's Officer-In-Charge (OIC) has designated the Project Quality Manager to have the responsibility for implementation and management of the Quality Management Program for the Booz Allen Team. The Project Quality Manager has direct access to the Booz Allen OIC, for any issues related with the Booz Allen project team.

On matters associated with establishing, implementing and maintaining the Quality Program, the Project Quality Manager will report directly to the SFMTA Project QA Manager. The Project Quality Manager has overall day-to-day responsibility for the Quality Program and will also report on the performance of the Quality Program for review and as a basis for continuous improvement.

The Project Quality Manager is delegated the authority and organizational freedom to identify and evaluate quality problems; to initiate, recommend or provide solutions; and to control further processing, delivery or installation of nonconforming or deficient items. When necessary to stop work, the Project Quality Manager will recommend to the SFMTA Project QA Manager to have a stop work order issued to a given contracting/consulting organization. The Project Quality Manager will review the recommendations for resolution of the stop work order. A stop work order will be removed in accordance with the review and approvals process described earlier in this document.

Specific activities include the following:

- Review contract documents to identify project quality requirements
- Provide primary interface and coordination for quality reviews, surveillances, or audits of the Quality Program by SFMTA, MRSR Project management, or other external auditors
- Coordinate the development, issuance, and maintenance of the QAP ensuring that the Quality Program adequately satisfies contract requirements
- Facilitate, through meetings, reports, reviews, trend analysis, test reports, surveillances, and audits, the effective implementation of the MRSR Quality Program by contractors, suppliers, and subcontractors within its respective work scope
- Conduct quarterly (or more frequent as required) MRSR Project quality management review meetings.
- Keep the SFMTA Project Quality Assurance Manager and SFMTA Project Manager informed regarding project quality matters
- Provide support to the SFMTA with quality requirements to the FTA
- Verify that the project Quality Program is effectively implemented and maintained through Quality Program audits, Quality Program surveillances, and quality management reviews
- Coordinate with the Design Manager, Engineer-of-Record, Contractor QC Manager, Quality Assurance Auditors, SFMTA Resident Engineers, and Design/Build Inspectors for construction quality status and problem resolution
- Monitor the project's overall implementation of the project Quality Program and analyze project quality metrics data, as appropriate, for quality trends and improvement opportunities
- Review the results of internal Quality Program audits for quality trends, effectiveness of corrective actions, and compliance to the project Quality Program requirements

- Issue certificates of compliance stating that for elements of work, all conditions to commencement of design/build as set forth in the approved QAP have been met
- Review all documentation and work completed by the Quality Engineers.

The Project Quality Manager is supported by Quality Assurance Auditors (Quality Engineers) and Design/Build Inspectors (Inspector) during design and implementation of the MRSR Project.

Booz Allen Team Quality Engineer

The Quality Engineer(s) will conduct audits and surveillance of all Project Team members. The Quality Engineer reports to the Project Quality Manager and must keep him/her informed of project quality matters.

Specific QA responsibilities include, but are not limited to:

- Conduct in-process audits/surveillances to determine whether approved QC procedures are sufficient, appropriate, followed, and effective
- Review material certification, samples, tests, and submittals
- Witness inspections of specially furnished equipment and fabricated design/build materials
- Witness inspections of design/build operations, hardware/software installation, and test activities
- Review results of inspections and tests
- Conduct or review audits/surveillance of Contractor's activities, including their subcontractors and suppliers
- Investigate and establish disposition of nonconformance items/events; confirm corrective actions are implemented as approved
- Establish and maintain corrective action logs
- Participate in quality review meetings as requested by SFMTA.

Design/Build Inspectors

The Design/Build Inspectors (Inspectors) will conduct inspections of project activities and prepare inspection reports, and any nonconformance reporting. Reports are copied to the SFMTA Resident Engineer and copied to the Project Quality Manager for general review. Based on these reports, the Project Quality Manager may conduct an audit of activities or take other necessary action. The Inspector reports to the Contractor's QC Manager and the SFMTA Resident Engineer for project direction, and to the Project Quality Manager for quality technical direction.

Specific inspection QC responsibilities include:

- Reviewing/approving material certification, samples, tests, and submittals
- Documenting daily reports on both direct hire and subcontractor work
- Confirming materials and equipment delivered to the job site comply with contract documents
- Performing inspections of specially furnished equipment and fabricated materials
- Inspecting construction operations, hardware/software installation, and test activities
- Recording results of inspections and tests
- Monitoring field testing activities
- Investigating and establishing disposition of nonconformance items/events
- Participating in quality review meetings as requested by SFMTA.

Project Quality Management Review

The purpose of the quarterly MRSR Project Quality Management Review (QMR) Meeting is to advise the SFMTA Quality Assurance Manager, the SFMTA Project QA Manager, and the project team of the status and implementation of the MRSR Project Quality Program and to review open items for resolution. The Project Quality Manager is responsible for scheduling, conducting, and reporting on the conclusions that were reached, observations and/or recommendations made and follow up action assigned.

The meeting agenda will be set by the Project Quality Manager and will include topics relevant to the MRSR Project schedule and activities, examples of which include:

- The effectiveness of the QAP
- The suitability of the QAP to continue without change
- The organizational structure, including the adequacy of staffing and resources
- Establish whether the defined quality objectives are being met
- Status of audits and surveillances
- Status of impending changes to the QAP
- Procedures issued or revised during the period
- QA/QC training sessions held during the period

- Status of Corrective Action Reports, new, outstanding, and recently closed
- Review potential trends of CARs for opportunities for preventive actions
- Status of new, outstanding, and recently closed preventive actions
- Status of trends or patterns in nonconforming products with association to design consultants, suppliers, contractors, subcontractors and design/build management contractors
- Quality-related items issued by SFMTA or FTA requiring corrective action
- Project quality issues
- Open quality items.

Personnel required to attend QMR meetings include, but are not limited to:

- SFMTA Project Manager
- SFMTA Project QA Manager
- SFMTA Project Engineer
- Booz Allen Project Manager
- Booz Allen Design Manager
- Booz Allen Project Quality Manager
- SFMTA Resident Engineer
- Quality Engineers, as required
- Inspectors, as required
- Contractor's Project Manager (phase 4)
- Contractor's Quality Control Manager (phase 4)
- Other contractors, suppliers, subcontractors, as required.

Related Procedures for 3.1 Management Responsibility:

Procedure 201: Quality Program Review

DOCUMENTED QUALITY MANAGEMENT PROGRAM

The MRSR Project Quality Program is the primary responsibility of the SFMTA Project QA Manager on behalf of the SFMTA, and the Project Quality Manager on behalf of the Booz Allen Team.

The Quality Program established for the MRSR Project provides an effective means of ensuring the services provided by the consultants, suppliers, contractors, and subcontractors conform to the quality policies of SFMTA and the MRSR Project QAP.

Project Quality Program

The documentation for the MRSR Project Quality Program is structured in a hierarchical relationship as shown in Figure 2 and described below.

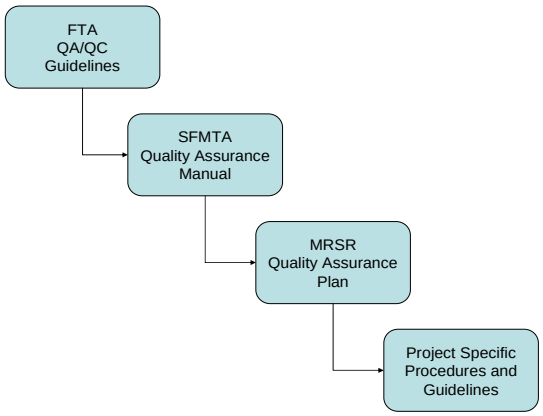


Exhibit 2: MRSR Project Documented Quality Program

The MRSR Project Quality Program is project-specified to the extent that it is a stand-alone program. The MRSR Quality Program ascertains that the products and services provided for the MRSR Project conform to the requirements of its contracts and SFMTA quality requirements. The MRSR Quality Program is comprised of the MRSR QAP, quality procedures, and associated project guidelines.

The QAP also identifies project-specific procedures and instructions to which the project work will be performed, recommended guidelines and includes the responsibilities and actions required for implementing the MRSR Project Quality Program (Section 3.1.2 – Responsibilities for Quality).

The Project Quality Manager has responsibility for performing quality verification activities independent of those having responsibility for the work being performed. Independent checking of design documents shall be by an individual of equal or higher qualification than that of the originator. This may be the supervisor where the supervisor is the only technically qualified person available.

Monitoring of the processes during design/build will be supervised and documented by the SFMTA Project Engineer and/or the SFMTA Resident Engineer with support from Quality Engineers and QC Inspectors as required.

Documentation of tests and inspections will be carried out in accordance with both SFMTA and the MRSR Project quality programs and is described in more detail in the QAP Section 3.8 – Inspection and Testing.

The MRSR Project Quality Program is applied to project activities including overall project control and management, planning, engineering, design, procurement, and implementation.

Quality Planning

Requirements for quality are defined and documented for the various activities. Quality planning includes the following, as appropriate:

- Identification and acquisition of any controls, processes, equipment, resources, and skills needed to achieve the required quality by the SFMTA QA Manager, the SFMTA Project QA Manager and the Project Quality Manager
- Managing and validating the compatibility of the final design, installation, inspection, and test procedures and the applicable documentation, through the Project System Integrator
- Updating of QC, inspection, and test techniques by the SFMTA Project Engineer, the Project Quality Manager, Design Manager, Resident Engineer and Quality Engineers, all as appropriate
- Identification of appropriate verification and inspection points by the SFMTA Project QA Manager, Project Quality Manager, Design Manager, Resident Engineer, Inspectors and Quality Engineers, all as appropriate
- Clarification and use of acceptable standards by the SFMTA Project QA Manager, Project Quality Manager, Project Manager, Quality Engineers and Inspectors
- Maintaining records by the Project Document Control Center.

DESIGN CONTROL

The Booz Allen Design Manager is responsible for design control for the conceptual and preliminary engineering work. During the design/build phase, the contractor shall identify the design manager who will report to the Engineer-of-Record and will be responsible for final design control.

Design activities will be performed by qualified personnel and will be in compliance with documented procedures. The procedures describe or reference these activities and define responsibility for their implementation. The design and development activities are assigned to qualified personnel equipped with adequate resources.

Organizational and technical interfaces between groups and external agencies providing input into the design process are defined and necessary information documented, transmitted, and regularly reviewed by the Design Managers.

Design input requirements, including applicable statutory and regulatory requirements, have been identified and documented, and their selection reviewed by the Booz Allen Team Design Manager for adequacy. Incomplete, ambiguous, or conflicting requirements will be resolved with those responsible for imposing these requirements.

Design input takes into consideration the results of any contract review activities. Design output is documented and expressed in terms that can be verified against design input requirements and validated.

Design output meets the design input requirements; contains or make reference to acceptance criteria; and identifies those characteristics of the design that are crucial to the safe and proper functioning of facilities, network infrastructure, equipment, installations, software, and interfaces.

At appropriate stages of design, formal documented reviews of the design results are planned and conducted. The Design Manager will determine which participants are appropriate for each design review, based on the design stage and element to be reviewed, as well as other specialist personnel as required. Design Review will be conducted in accordance with the Design Control Procedures listed herein, and records will be maintained in accordance with Section 3.13 – Quality Records. The Design Manager shall be responsible for confirming that all design review documents and activities are in accordance with procedures and requirements.

At appropriate design stages, the design is verified to ensure that design stage output meets design stage input requirements. In addition to design reviews, design verification may also include activities such as:

- Reviewing software programs used to determine calculations
- Performing alternative calculations that are easily identifiable by subject
- Comparing the new design with a similar proven design, if available
- Undertaking tests and demonstrations
- Reviewing the design stage documents before release
- Review for consideration of historical data, e.g.: lessons learned.

Where electronic drafting software is employed, the data and models used in the development of the designs must be checked for conformity to established standards and approved by the Design Manager prior to design verification and validation. This is to prevent data integrity errors and loss of data that would result in reworking of subsequent revisions.

Design verification measures are recorded and maintained in accordance with Section 3.13 – Quality Records, and conducted in accordance with the Design Control Procedure listed herein.

Design validation is performed to confirm that facilities, network infrastructure, equipment, installations, software, and interfaces conform to SFMTA needs and/or requirements. Design validation is performed subsequent to successful design verification. Validation is normally performed under defined operating conditions on the final product, but may be necessary in earlier stages before product completion. Multiple validations may be performed if there are different intended uses of the product.

Review, approval and sealing/stamping of final design documents will be done by the Contractor's Engineer-of-Record, a licensed professional engineer, in accordance with applicable statutory requirements.

Design changes and modifications are identified, documented, reviewed, and approved by the Engineer-of-Record or his/her designee prior to implementation.

As-built drawings and record documents will be developed during the design/build phase to accurately reflect the final design and construction conditions.

Related Procedures for 3.3 Design Control:

Procedure 301: Design and Change Control

Procedure 302: Design Review Process

DOCUMENT CONTROL

Document control is the primary responsibility of the Document Control Manager for SFMTA and Booz Allen generated documents. Confidential documents will be inputted by the respective organizations. All other documents will be processed by the Document Control Manager via the Booz Allen PIMS program.

The Booz Allen Team has established and implemented procedures for controlling documentation and data produced by all parties on the MRSR Project team. The procedures will integrate with other elements within the Quality Program and the contract to control and maintain both hard copy and electronic documentation. Such documents include, but are not to be limited to, project procedures, specifications, material requisitions, drawings, and data sheets.

Project documentation is managed and processed using a computerized document control system PIMS, as established by Booz Allen. The computer-generated document control logs are reviewed by the Document Control Manager for thoroughness and accuracy before issuance for management reports.

The responsibilities of the Document Control Manager and staff include, at a minimum:

- Processing incoming and outgoing documents, including document coding
- Maintaining and updating distribution lists, and distributing documents on a timely basis
- Maintaining and updating project team signatures/initials list
- Marking and removing (if appropriate) obsolete documents (as directed by the document originators)
- Filing and numbering documents in accordance with an established file indexing system
- Document retrieval, upon requests from the Project Team
- Creating management reports as directed by Project Team managers to report on relevant information
- Archiving documents.

Document changes/modifications are controlled in the same manner as original documents using a computerized document control system.

The Project Quality Manager will perform reviews of selected documents and activity logs to evaluate compliance as part of the normal monitoring and audit/surveillance functions.

Record Retention

Times of record retention are divided into two categories of permanent and non permanent.

Permanent records are for records that:

- Provide significant value in demonstrating safe design, design/build and the capability of safe operation
- Provide baseline data for inspection and testing
- Provide significant value in maintaining, reworking, repairing, replacing, modifying or otherwise supporting an item
- Provide significant value in determining the cause of an accident, or malfunction of an item.

Non-permanent records generally have a contractual limited retention time. Records will be maintained for a period of three years after the payment of the final invoice.

Related Procedures for 3.4 Document Control:

Procedure 401: Document Control Procedure

PURCHASING

SFMTA has established and maintains procedures to determine whether purchased products conform to specified requirements. The purchasing procedures document the processes for evaluating contractors, suppliers and subcontractors; preparing, reviewing, and approving purchasing documents; and, where appropriate, verifying purchased product at the contractor's, supplier's and subcontractor's premises either by the supplier or the customer. No new design or design/build work shall commence until SFMTA has provided approval to proceed.

The purchasing objectives are to:

- Confirm that purchased items and services can conform to contract requirements and specifications
- Qualify and select suppliers, subcontractors and consultants
- Establish warranty claim terms and conditions.

Review of procurement activities fall into three major categories: procurement documents, source selection and source surveillance/inspection. The SFMTA Project Manager is responsible for overseeing that purchasing activities are compliant with relevant procedures and guidelines.

Procurement Documents

Applicable design basis and QA program requirements will be included or referenced in documents used for procurement of services and commodities.

Quality program requirements applicable to lower-tier contractors or suppliers will be specified.

Procurement documents for items and services will include a statement of the scope of work to be performed by the supplier.

Documents which are used to procure services/materials are to be reviewed by the Project Quality Manager to verify that data necessary to assure quality is included or referenced in such documents. Revisions to these documents are subject to the same review as the original.

The Project Quality Manager can also perform reviews of selected procurement packages to evaluate the adequacy of the Quality Program requirements imposed on the Contractor/supplier as part of the normal monitoring and audit/surveillance functions.

Source Selection

Source selection will be conducted in accordance with SFMTA policies which comply with federal standards for fair and open procurement practices. SFMTA will also evaluate the ability of contractors/suppliers to meet program QA/QC requirements prior to the contract award.

Based upon positive results of the evaluation, vendors/suppliers will be considered qualified to meet procurement quality requirements.

Source Surveillance/Inspection

When source surveillance or inspection is necessary, requirements will be established and reviewed with the supplier. Criteria for inspections and surveillances are established by the Project Quality Manager, and reviewed in the quarterly management review. Where applicable, initial surveillance/inspection can include a review of fabrication drawings to verify compliance with codes, specifications, and purchase order requirements. Materials can be reviewed and verified as required. Documented evidence of all surveillance/inspection is to be maintained as Quality Records by the Document Control team.

PRODUCT IDENTIFICATION AND TRACEABILITY

Product identification and traceability is the primary responsibility of the Design/Build Contractor. The Contractor will be required to provide daily quality control for the installation of the new radio system, as well as periodic quality audits surveillance.

Product identification and traceability is used to control usage, installation and disposition of materials, parts, components, equipment, and products, and prevent the use of incorrect or defective items. Additionally, product identification and traceability allows for accurate warranty claim management for defective items after project implementation.

Proper identification, control of material, items throughout all stages of production, handling, storage, shipment, delivery, installation, and testing shall be as specifically imposed by contract, specification, and/or other documents. This identification and control shall also be extended to include spare parts.

SFMTA has established and maintains procedures that describe methods used for identification and traceability of test equipment, materials, and equipment used by SFMTA or supplied by SFMTA during the execution of the contract. Contractors, subcontractors and suppliers will have comparable requirements consistent with this QAP in their quality programs.

Identification nomenclature for SFMTA-supplied materials and test equipment used on the contract include, as appropriate:

- Part/assembly or identification number
- SFMTA contract number
- Manufacturer's name
- Manufacturer's part/assembly number
- Serial numbers
- Date received
- Serial, lot, or batch numbers
- Calibration reverse traceability for test equipment, as required
- Material Safety Data Sheet, as required.

As a result of this need for proper identification and control of material/items, SFMTA will require the following:

- The Project Quality Manager will conduct audits and oversight as necessary to maintain a reasonable assurance that the contractor/subcontractor/supplier processes are maintained and effectively carried out on a continuing basis. The audit and oversight activities will confirm that purchased parts are identified by positive markings and/or certifications.
- The contractor must establish and implement procedures to assure that proper materials are drawn and installed in accordance with the approved design; oversight by the manufacturer's QA staff should be included as applicable.
- Parts/materials that are received without satisfactory identification or that are otherwise untraceable, must be segregated and not used unless re-identified/re-certified by the manufacturer's QA staff.
- Traceability of manufactured items will be maintained through unique serialization to the minimum requirement of the contract specification.
- Items that have been inspected and confirmed to be discrepant shall be marked as such.
- Procedures will be established and maintained to monitor that when any and all SFMTA supplied items are shipped to the MRSR Project, said items will be properly documented, controlled, and of acceptable quality.

PROCESS CONTROL

Process control is the primary responsibility of the Design/Build Contractor.

The quality procedures and project-specific procedures document the work processes used in the MRSR Project to execute and control quality-related activities. Suppliers and subcontractors will have comparable requirements consistent with this QAP in their quality programs.

Work processes executed by contractors, suppliers, and subcontractors that directly affect quality are identified, planned, and conducted under controlled conditions through appropriate use of the following:

- Documented procedures defining the manner of production, installation, and servicing, where the absence of such procedures could adversely affect quality
- Use of suitable production, installation, and servicing equipment and a suitable working environment
- Compliance with reference standards/codes, quality plans, and/or documented procedures
- Monitoring and control of suitable process parameters and product characteristics
- The approval of processes and equipment, as appropriate
- Criteria for workmanship, which is stipulated in the clearest practical manner (e.g., written standards, representative samples, or illustrations)
- Suitable maintenance of equipment to provide continuing process capability.

Monitoring of the work processes and product characteristics will be performed through the use of surveillance, hold-point inspections, report reviews and/or audits. The Project Quality Manager and/or Quality Engineer will perform planned and systematic reviews and/or audits of processes and procedural compliance where results of processes cannot be fully verified by subsequent inspection and/or testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use. The processes are carried out by qualified personnel and/or require continuous monitoring and control of process parameters to confirm that the specified requirements are met.

Before the commencement of any of the aforementioned special processes, the documentation of the qualified processes, equipment and personnel is to be secured by the contractor and submitted to the Project Quality Manager.

The requirements for any qualification of process operations, including associated equipment and personnel, are specified as appropriate in specifications, procedures, and work procedures.

Suitable Maintenance of Equipment to Provide Continuing Process Capability

Before the commencement of normal operations, the SFMTA Project Manager will define a maintenance program, with service and spare parts provisions, as required to support routine and non-routine maintenance events. Elements to consider when evaluating such a plan include:

- Maintenance intervals and scope for routine maintenance of facilities, network infrastructure, equipment, installations, software, and interfaces
- Engineering estimates for Mean Time Between Failure (MTBF) and Mean Time Between Unscheduled Removal (MTBUR) to evaluate the forecast demand for non-routine maintenance events
- Spare parts availability lead time, contracts, and forecast budgetary estimates to provide adequate material, so as to avoid operational disruption
- Service provider (internal or external) capability, capacity, contracts, and budgetary estimates to provide adequate maintenance services, so as to avoid operational disruption
- Classification of Hazardous Materials is accomplished to ensure proper handling in accordance with the Code of Federal Regulations Title 49 (Transportation), Title 29 (Labor), as well as applicable state and local Fire codes.

Documentation of other locations where the manufacturers' have installations of the equipment selected for the MRSR Project will provide baseline data for comparative evaluation. As an option, these locations may serve to provide collaborative sourcing of spare parts in the event the equipment becomes obsolete and can no longer be procured.

INSPECTION AND TESTING

Inspection and testing is the primary responsibility of the contractor's Quality Control Manager. The SFMTA Resident Engineer and support staff will provide oversight and approvals as determined to be necessary.

The goal of inspection and testing is to ensure conformance and credibility of inspection and testing performed by contractors, suppliers, subcontractors and testing organizations during this project. This section applies to all activities related to supervision or performance of project inspections and tests including receiving, in-process, and final inspection and testing.

SFMTA and the Booz Allen Team have established procedures that describe the methods of inspection and test employed or witnessed by SFMTA and/or Booz Allen Team representatives during the course of this project. contractors, suppliers and subcontractors will have comparable requirements consistent with this QAP in their Quality Programs.

The contractor shall be required to develop a comprehensive Test Plan, integrating inspection and testing activities from all subcontractors and suppliers. The Test Plan shall be submitted to SFMTA and the Booz Allen Team for review and approval as described herein.

Inspection and/or test activities will be monitored, evaluated, and documented. The SFMTA Resident Engineer is responsible for control of inspection and test activity and conformance of that activity to the contract specifications.

There will be inspection and test activity coverage at the following points in the production cycle, as required:

- First article
- Receiving
- Small parts manufacture
- Subassembly
- Assembly
- In-process
- Test
- Final
- Shipping
- Acceptance site
- Construction/build
- Installation
- Commissioning.

Commercial off the shelf products (COTS) require inspections from shipping to commissioning only.

For software and radio operations, there is inspection and test activity coverage at the following points in the production cycle, as required:

- Requirements review
- Unit test
- Integration testing
- System interface testing
- User Acceptance testing
- Coverage, frequency and range testing, for radio operations
- Initial inspection and testing upon system deployment into service.

Contractor Responsibilities

Control and verification of the quality of work performed by the contractor and its subcontractors/suppliers is ultimately the responsibility of the contractor's Quality Control Manager. The contractor will be required to submit a Quality Control Plan and a Test Plan. Prior to implementation, the submitted plans and its revisions are to be approved by the SFMTA Resident Engineer and the Project Quality Manager, and accepted by the SFMTA Project QA Manager. The SFMTA Resident Engineer and the Project Quality Manager will confirm that the Quality Control Plan and the Test Plan can demonstrate product conformance and nonconformance to project requirements, including when executed in acceptance testing. The plan must also specify and describe methods for controlling the quality of work performed by subcontractor and suppliers.

To assist the contractor in awareness and execution of the inspection function, the Project Quality Manager will prepare a series of inspection guidelines that provide important checkpoints by which to direct and facilitate more effective observation. The inspection guidelines are intended to provide the contractor with a set of recommendations and reminders based on generally accepted industry practice. The inspection elements in the guidelines are not intended to replace specific design/build contract requirements, industry codes or standards, but will provide reference material on good work practices and inspections typically recommended for the specific type of work covered.

The contractor will clearly and accurately document on the appropriate form, the work accomplished and conditions encountered on each contractual day (including weekends).

Each subcontractor is responsible for performing its own quality control inspection and for completing the required documentation and records that will be turned over as part of the project deliverables and record documents. These inspections and tests are to be described in the contractor's QC Plan. This plan can be implemented only after the approval by the SFMTA Resident Engineer and the Project Quality Manager.

The contractor is also to assume responsibility for the inspection of work being performed by their subcontractor and suppliers. This monitoring can be demonstrated by objective evidence in the form of documented inspection results, lab reports/test results or certifications of conformance as specified. This monitoring is to be described in the Contractor QC Plan.

Acceptance Testing

SFMTA and the Booz Allen Team will be responsible for monitoring and approving acceptance testing during Phase 4 of the MRSR Project. Acceptance testing is regular testing of materials entering a design/build project to verify that the materials and/or products comply with contract specifications and standards.

The contractor will engage an independent testing laboratory, as approved by the SFMTA Resident Engineer and the Project Quality Manager, to perform required sampling and testing. The proposed testing laboratory shall be accredited by an acceptable accreditation program. The proposed laboratory is subject to quality audits and surveillances by the Project Quality Manager, to verify that industry test standards are upheld.

Testing of Manufactured Materials **(Factory Acceptance Test)**

Contractors and their suppliers are to establish procedures required for inspection, testing and acceptance of manufactured and prefabricated materials, either by source inspection/testing, job site inspection/testing, or certificate of compliance, to ensure compliance with contract requirements. These procedures are to be included in the Contractor QC Plan and the Contractor Test Plan for submittal and approval by the SFMTA Resident Engineer and the Project Quality Manager prior to the fabrication of the materials.

Source inspection/testing is acceptance testing of manufactured and prefabricated materials at locations other than the job site and shall be performed by approved testing laboratories. The SFMTA Resident Engineer and the Project Quality Manager (or their designees) will witness these tests. The SFMTA Project QA Manager also reserves the right to witness these tests.

SFMTA Quality Control Responsibilities

The SFMTA Resident Engineer is responsible for day-to-day monitoring of the Contractor's quality control activities. Using SFMTA and Booz Allen Inspectors, the SFMTA Resident Engineer will monitor the Contractor's Quality Control Plan implementation through inspection and independent sampling and testing.

Quality Assurance Oversight

The Project Quality Manager and/or the Quality Engineers will conduct QA oversight to verify that appropriate examinations, tests, measurements and inspections are being properly performed and documented by the Contractor, the SFMTA Resident Engineer, independent testing laboratories, the Contractor's QC Manager and their Inspectors.

The Project Quality Manager may be assisted by the various technical engineering disciplines assigned to verify that the Contractor/supplier work processes and installation activities conform to program requirements.

The Project Quality Manager and/or Quality Engineer will monitor the Contractor's measuring and test equipment calibration and control processes for compliance with contract requirements, calibration industry standards and Contractor's quality procedures.

Where the products or material fails to pass any design criteria or contractually imposed specification during inspection or test, the procedures for nonconformance shall apply.

Quality Assurance Audits

Initial audits, and such additional periodic audits as indicated necessary based on observed results of the contractor's general inspection procedures, will be conducted by the Project Quality Manager in accordance with the following guidelines:

Incoming/Receipt Inspections

All purchased items, including spares, received will be subject to incoming inspections to confirm that only approved materials, equipment and supplies are delivered to the project site. Certificates of compliance attesting to the quality of material, equipment, and supplies as may be required by contract, purchase order, or standard practice will also be checked.

Handling, storage, packaging, preservation, and delivery are the primary responsibility of the contractor.

Source Inspections

The Contractor's Quality Control Manager will determine when source inspection at supplier/subcontractor plant(s) is required. Such determinations are normally based on complexity of the subcontracted items, economic benefit, assessment of the subcontractor's quality program, and results of receipt inspections. COTS products are not subject to source inspections.

First Article Inspections

First article inspections are conducted on the first production unit of all major components/systems, prior to its delivery to confirm compliance with contract requirements, including engineering tests and physical examinations. The first article inspections provide opportunities for the inspection team to observe and assess the vendor's manufacturing and QC processes. COTS products are not subject to first article inspections.

In-Process Inspections

In-process inspection is essential to all manufacturing, assembly and design/build operations and is the prime responsibility of the contractor. COTS products are not subject to in-process inspections.

Final Acceptance Inspection

When the contractor believes that a given feature, segment, or end product is completed and ready for final acceptance, they provide notification that the work is complete and ready for final acceptance. The Inspector will perform a final inspection to verify that all required work has been completed and that the presented work/product is compliant with the specification. Product found deficient in relation is identified as nonconforming, and the nonconformance is resolved by corresponding corrective action(s). The SFMTA Resident Engineer and the Project Quality Manager (or their designees) will witness these tests. The SFMTA Project QA Manager also reserves the right to witness these tests.

INSPECTION, MEASURING, AND TEST EQUIPMENT

Control of inspection, measuring, and test equipment is the primary responsibility of the equipment owner.

SFMTA and the Booz Allen Team have established and maintain procedures that describe the management and control of inspection, measuring, and test equipment (including test software) used to demonstrate the conformance of product to the specified requirements. Contractors, subcontractors and suppliers will have comparable requirements consistent with this QAP in their quality programs.

The Project Quality Manager and/or Quality Engineer will monitor the contractor's, subcontractor and supplier's control, calibration, and maintenance of inspection, measuring, and test equipment used throughout the project. It is the contractor's responsibility to ensure that equipment capabilities and measurement uncertainty is known and is consistent with the required measurement capability.

INSPECTION AND TEST STATUS

Inspection and test status is the primary responsibility of the Contractor's Quality Control Manager.

SFMTA and the Booz Allen Team will establish and maintain procedures to control inspection and test status so that only acceptable items are identified and used throughout the design/build phases. Contractors, subcontractors and suppliers will have comparable requirements consistent with this QAP in their quality programs.

This section applies to all items supplied by contractors, subcontractors or suppliers to satisfy the MRSR Project requirements. The inspection and test status of a product is identified and maintained as necessary, during all stages of production and installation, validating that only products that have passed the required inspection/test are installed or released. Inspection and test status is signified by the use of authorized markings, stamps, routing cards, inspection records, or other means that indicate conformance or nonconformance with specified requirements.

The Contractor's Test Plan, which includes applicable test plans for the subcontractors and suppliers, will be approved as described in Section 3.8. This activity may include on-site surveillance at the suppliers'/manufacturers' facilities, and/or review of applicable test reports before further processing.

NONCONFORMANCE

Control of a nonconforming product is the primary responsibility of the Design Managers, the Project Quality Manager, the SFMTA Resident Engineer and the Contractor's Quality Control Manager.

SFMTA has established and maintains procedures to describe the methods used to identify, segregate, and disposition nonconforming items that are found during the execution of this Quality Program. Contractors, subcontractors and suppliers will be required to have comparable requirements consistent with this QAP in their Quality Programs.

Any product that does not conform to specified requirements is identified to prevent use, further processing, installation, or mixing with conforming products. The relevant functions are notified and the nonconforming product segregated or "controlled-in-place" pending evaluation and disposition.

The identification of a nonconforming item may occur during a field inspection, surveillance inspection or by review of documentation by any Project Team member.

The identification of nonconforming occurrence/material may be accomplished by the designer, contractors, subcontractors and suppliers in accordance with methods described in their approved QC Plans, and is meant to preclude its further use without proper authorization. Most commonly a method of "tagging" and/or segregating, if applicable, is used. Segregation may not always be feasible due to size, configuration or installation location. In any regard, the process for identification of nonconforming material must have the effect to preclude its further use without proper authorization.

Field non-conformances are to be documented by the contractor, the Booz Allen Team or SFMTA staff, in accordance with established procedures.

Non-conformances occurring inside a supplier's plant must also be accountable to similar requirements and processes in accordance with the approved supplier's QC Plan.

Tracking and closure of nonconformance instances initiated in the supplier's plant are to be accomplished by that plant's QA group, but is auditable by the SFMTA or the Project Quality Manager.

At a minimum, a nonconformance report, written by the designated quality representative(s), is to document the following: description of the condition adverse to quality, approved disposition/instructions (i.e. reject, rework, repair, or accept as is), corrective actions taken, and results of re-inspection after corrective work (if any) has been completed.

The decision to scrap, rework, reassign to alternative applications, or accept with or without repair (waiver to specified requirements) is made by the appropriate SFMTA designated authority, e.g. the Resident Engineer, with the approval of the appropriate manager. A repaired or reworked product is re-inspected in accordance with documented procedures.

All non-conformances are to remain in an open status until satisfactory corrective action has been implemented.

The Project Quality Manager is to monitor the contractors/suppliers' QC procedures for control, processing, and correct informational content of nonconformance reports. Additionally, the Project Quality Manager will prepare trend reports identifying patterns in nonconforming products with association to design consultants, suppliers, contractors, and subcontractors for the Quality Management Review Meeting.

Related Procedures for 3.11 Nonconformance:

Procedure 1102: Control of Nonconforming Products

Procedure 1202: Nonconformance and Corrective Action

CORRECTIVE ACTION

Corrective action monitoring is the primary responsibility of the Project Quality Manager.

SFMTA and the Booz Allen Team have established and maintain procedures that describe the methods to identify, correct, and prevent actual or potential nonconforming product. Non-conformances will be reviewed and investigations will be initiated as necessary, to determine the root-cause, corrective and preventive actions (if required to preclude recurrence).

Contractors, subcontractors and suppliers will be required to have comparable requirements consistent with this QAP in their quality programs.

The cause(s) of non-conformances will be investigated by a knowledgeable team convened by the Project Quality Manager. The Project Quality Manager validates that the effectiveness of the action(s) taken are demonstrated and recorded. Audits, surveillances, and/or analysis of work processes, operations, concessions, and quality records may be made by the Project Quality Manager to detect and eliminate actual and potential causes of nonconformance. Relevant information on actions taken will be assessed at the Quality Management Review Meetings. Preventative actions taken are at a level that corresponds to the risks encountered. Records are maintained that document all changes to the Quality Program and procedures that result from corrective action.

The Project Quality Manager will maintain the log of non-conformances and will prepare reports status of new, open, and recently closed corrective action reports for the Quality Management Review Meetings.

Related Procedures for 3.12 Corrective Action:

Procedure 1202: Nonconformance and Corrective Action

QUALITY RECORDS

Control of Quality Records is the primary responsibility of the Document Controls Manager.

The intent of the record keeping function is to generate and maintain the required quality records to demonstrate MRSR Project's achievement of quality. Quality records also provide evidence of the effective implementation

of the MRSR QAP. Quality records include all the documentation required by this plan, including procurement records, supporting procedures, manuals and specifications.

Procedures have been established to identify, collect, index, access, file, store, maintain, and dispose of quality records. These procedures were established using SFMTA criteria, while tailoring the documents to the requirements of the MRSR Project.

At the program level, the types of records required and retained include:

- Procurement documentation (solicitation document, contract documents, change orders, etc.)
- Quality management review records
- Design review records
- Design verification records
- Software specifications and requirements
- Approved subcontractor bidders list
- Identification records of customer-supplied product
- Product identification records
- Records of qualified processes, equipment, and personnel
- Inspection authority responsible for product release record
- Calibration records of inspection, measuring, and test equipment
- Records of nonconforming product
- Audit and Surveillance reports
- Training records
- Contractor submittals
- Contractor QA/QC plans
- Drawings
- Product specifications
- Nonconformance reports
- Corrective actions
- Test reports.

Records are maintained in a location where they are protected against deterioration, damage, or loss. Access to quality records will be provided to auditing agents for the purpose of conducting surveillance and/or audits to verify the implementation of the Quality Program.

Related Procedures for 3.13 Quality Records:

Procedure 1301: Quality Records

QUALITY AUDITS AND SURVEILLANCES

Quality audits and surveillances are the primary responsibility of the Project Quality Manager.

SFMTA and the Booz Allen Team have established a program of planned documented internal and external quality audits as directed by the Project Quality Manager. The Project Quality Manager will use qualified Quality Engineers to conduct audits to verify that the applicable elements of the Quality Program have been properly initiated, implemented, and documented, and to determine the effectiveness of the Quality Program and identify areas of improvement.

The Project Quality Manager will also conduct quality surveillances to verify the acceptability of work in-progress and the compliance with project requirements. Quality surveillances supplement formal quality audits and are also used to verify the proper completion of specified corrective and preventive actions. Surveillances may be scheduled or unscheduled. Procedures for Quality Audits and Quality Surveillance describe the distinctions between the intent and processes for these activities.

The audit schedule requires at least one audit of all applicable departments, facilities, and organizations (internal or external) per year. The audit frequency of any department, facility, or organization may be modified as a result of ineffectiveness detected during operations or previous audit activity. The audit schedule will include planned surveillances as well.

Audits/surveillances are scheduled on the basis of the work completed and the importance of the activity. The frequency may vary depending on the nature and importance of the activity being performed and the results that will be achieved.

As part of audit planning, it is the Project Quality Manager's responsibility to assign Quality Engineers with experience and training to be commensurate with the audit assignment. Quality Engineers will be assigned based on their subject-matter experience and their independence from influences which could affect objectivity of the audit results. The qualifications, education, training, and experience resumes/records of all the auditors are maintained by the Project Quality Manager and are updated annually. Technical specialists may be utilized under the direction of the Quality Engineer, to independently review/assess technical adequacy and acceptance of, specialized products being audited.

In preparation of an audit, the Quality Engineers will review all relevant technical documents used in the execution of the contract and the results of any previous audits.

Prior to the execution of an external audit, the Project Quality Manager will notify the entity of the time, duration and scope of the audit.

Audits and surveillances may be conducted on the SFMTA, Booz Allen Team, the contractor and any subcontractors and suppliers. Audit and surveillance reports are prepared and formally submitted to the audited organization.

The audited organization must provide corrective action statements and rectify all discrepancies noted in the original audit report before scheduling a follow-up audit. The management personnel responsible for the area audited shall take timely corrective action on deficiencies found.

Related Procedures for 3.14 Quality Audits and Surveillance:

Procedure 1401: Quality Audits

Procedure 1402: Quality Surveillance

TRAINING

Training is the primary responsibility of the individual managers and the Project Quality Manager.

The Booz Allen Team has established and maintains a procedure for training. Contractors, subcontractors and suppliers will have comparable requirements consistent with this QAP in their quality programs.

The individual managers are responsible for defining the training needs of their group or department, validating the contents of their training program, establishing training methods, and implementing training programs. All MRSR Project Team members will receive Quality Program training.

Personnel participating in quality audits and inspection activities shall demonstrate, by objective evidence, that they qualify based on education, experience and demonstrated proficiency. Qualification records are to be maintained and periodically reviewed by the Project Quality Manager.

Related Procedures for 3.15 Training:

Procedure 202: Quality System Training

REFERENCE DOCUMENTS

The following SFMTA documents may be referenced for guidance, as appropriate.

- Muni “Comprehensive Project Management Plan”
- Muni “MRSR Project Management Plan”
- Muni “Project Operations Manual”
- Muni “Facilities Engineering Section Procedures”
- Muni “Construction Engineering Division Procedures”
- Muni “Construction Internal Procedures (Approval Required)”
- “Inspection Guidelines”.

appendix **eleven**

Buy America

BUY AMERICA REQUIREMENTS

If steel, iron, or manufactured products (as defined in 49 CFR Sections 661.3 and 661.5) are being procured, the appropriate certificate as set forth below shall be completed and submitted by each bidder or offeror in accordance with the requirement contained in 49 CFR Sec. 661.13(b). **Complete and sign only one of the following certificates.**

Buy America Certificate

Procurement of Steel, Iron, or Manufactured Products

(applicable to procurements greater than $100,000)

Certificate of Compliance with Buy America Requirements

The bidder or offeror hereby certifies that it will comply with the requirements of 49 U.S.C. 5323(j)(1), and the applicable regulations in 49 CFR part 661.

Date_____

Signature_____

Company_____

Name_____

Title_____

Certificate of Non-Compliance with Buy America Requirements

The bidder or offeror hereby certifies that it cannot comply with the requirements of 49 U.S.C. 5323(j), but it may qualify for an exception to the requirement pursuant to 49 U.S.C. 5323(j)(2), as amended, and the applicable regulations in 49 CFR 661.7.

Date_____

Signature_____

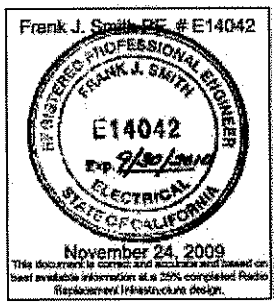
Company_____

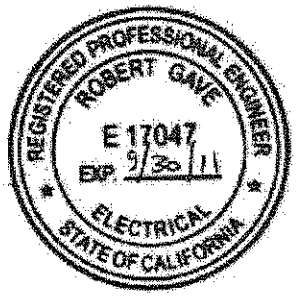
Name_____

Title_____

appendix **twelve**

Technical Specifications


Frank J. Smith PE # E14042
REGISTERED PROFESSIONAL ENGINEER
FRANK J. SMITH
E14042
EXP. 9/30/11
ELECTRICAL
STATE OF CALIFORNIA
November 24, 2009
This document is correct and accurate and based on best available information at a 25% completed Radio Replacement Intersections design.



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Section 8 - Training, Support, and System Maintenance

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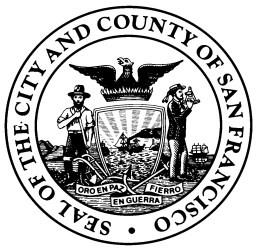

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General Requirements

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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1.0 General Requirements

These general requirements shall pertain to development of the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN).

It is the SFMTA's intent to procure, via a design-build project, a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by selected the SFMTA staff and CCSF public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users)
- A number of options including but not limited to interfaces to Automatic Passenger Counting (APC), Traffic Signal Priority (TSP), encryption, and a yard management system.

***Note: **Appendix Twenty Eight (28), "Cost Proposal Form"** requires Qualified Proposers to specify the cost for the combined MTMS and PSVRN. In addition to this, Qualified Proposers shall list on this form the cost for the Deductive Alternate, deleting the Project-25 based PSVRN system.

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFMTA's Lenox Way Operations Control Center, the SFMTA's One South Van Ness headquarters, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave communications system, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

As part of this design-build project, the Lenox Way Operations Control Center theatre will be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to accommodate rubber-tire vehicle dispatchers.

This RFP assumes a five (5) site communication (RF) system with two (2) central control sites.
The communication sites, as illustrated in **Appendix Nine (9), "Drawings"** include:

- Bernal Heights
- Forest Hill
- One Market Plaza
- South Hill
- Twin Peaks.

An additional site at the Clay/Jones building may be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco
- An interim rubber-tire dispatch center at the SFMTA headquarters at One South Van Ness Avenue, San Francisco, to facilitate renovation of the Operations Control Center at 131 Lenox Way, San Francisco
- Vehicle maintenance facilities, emergency operations center and other facilities.

1.1 Task Areas of Work

1.1.1 SFMTA Sites

Work shall be performed at all of the relevant SFMTA sites, including, but not limited to the sites listed to follow. The Contractor shall acquire all necessary safety training and certifications to access and work at these sites, as listed in **Section II "Scope of Services".** Site access generally requires the coordination of escorts or clearances. Excluding radio sites, backhaul, and fiber optic cable equipment locations, the SFMTA has the following sites and structures that are relevant to the MTMS and PSVRN:

Site Name	Street Address
Signal Shop	400 Cesar Chavez St.
Cable Car & Rail Systems	1201 Mason St.
Technical Training	501 Cesar Chavez St.
Duboce Station (at Church St.)	300 Duboce Ave.
California and Powel Streets signal tower	California and Powell Streets
Flynn Center	1940 Harrison St.
Green Light Rail - Annex	425 Geneva Ave.
Green Light Rail - Geneva	2301 San Jose Ave.
Green Light Rail - Metro	2200 San Jose Ave.
SF GO	25 Van Ness Ave. #210
Islais Creek-Under construction	1301 Cesar Chavez St.
Kirkland	151 Beach St.
Central Control	131 Lenox Way
Muni Metro East	601 25th Street
MUNI ETI	Pier 15 @ Embarcadero
Materials Management	1580 Burke Avenue
Marin Street	1399 Marin St.
Overhead Lines	1401 Bryant St./ 2502 Alameda St.
Pennsylvania	700 Pennsylvania St.
Potrero Division	2500 Mariposa St.
Presidio Division	949 Presidio Ave.
Fare Enforcement and Security	875 Stevenson St
MTA Headquarters	1 S Van Ness Ave.
Interim Central Dispatch Center	1 S Van Ness Ave. 8th Floor
Woods Transportation	1001 22nd St.
Woods Maintenance	1095 Indiana St.

In addition, the SFMTA operates in the following below-ground and tunnel structures:

Market Street Subway and Twin Peaks Tunnel including Muni Metro Turnback and stations
Muni Metro Sunset Tunnel
Broadway Tunnel
General Douglas MacArthur Tunnel
Stockton Tunnel
Geary Blvd. underpass at Presidio Ave.
Yerba Buena Tunnel on Treasure Island.
Cable car below grade structures
Central Subway – Under construction

1.1.2 Site Access

Before work at a site can commence, the Contractor shall have obtained written permission from the SFMTA to access the site. The request for site access shall delineate and describe, as part of the permission request, any special ingress or egress requirements, including coordination of escorts if necessary. Further information is contained in **Section IX: "Special Provisions".**

The Contractor shall have final responsibility to arrange for and ensure site access at proposed sites.

1.1.3 Licenses and Permits

The Contractor shall be responsible for preparing and obtaining any and all applicable approvals, licenses, and permits other than FCC licenses and Association of Public Safety Communications Officials International (APCO) authorizations.

The Contractor is responsible for licensing and permitting of the selected sites and shall include, but not be limited to:

- Researching and reviewing all land titles, tax maps, and reference deed information that might be needed.
- Confirming regulations to clearly understand applicable zoning regulations, environmental regulations, and building permits at the local, county, state, and Federal levels. The Contractor shall work closely with the SFMTA staff to ascertain the adherence to procedures, as required, to obtain zoning and building permits
- Reviewing, preparing, and securing applicable environmental body approval(s), including approvals regarding stream encroachment, flood plains, and wetlands
- Preparing zoning drawings for zoning application(s), including, but not limited to, site plans, elevations, site boundary survey, antenna specifications, and computer-enhanced photograph(s)
- Submitting zoning or planning commission application(s) for the construction or modification of any antenna support structure(s) where required
- Attending zoning or planning commission hearing(s) if necessary
- Requesting necessary Federal Aviation Administration (FAA) clearance(s) using *FAA Form 7460-1, Notice of Proposed Construction or Alteration*
- Working with the local jurisdiction and any appropriate legal counsel to obtain documentation attesting that all the property taxes on the subject property have been paid and are current
- Reviewing a “title report” to ensure that there are no problems with the title that would affect future lease agreements or zoning applications
- Preparing a request for a Phase I Environmental study to be completed, as needed
- Preparing construction drawing(s) to submit to site managers for the construction or modification of any antenna support structure(s) required, if necessary
- Preparing building permit application(s), including construction drawings, site plan, elevations, site boundary survey, and antenna specifications
- Securing applicable building permit(s)
- Preparing and submitting all necessary documentation in support of the SFMTA in meeting California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements.

1.2 Hardware and Software

1.2.1 System Wide Defects

Any component installed shall be subject to a global replacement in case an annual component failure or non-conformance rate of 10% is exceeded. The annual period starts with the first production installation of the respective component type.

In such case, the Contractor shall affect a redesign to correct this system wide defect. The new proposed design shall be submitted to the SFMTA for design review. After correcting the defect, the Contractor shall promptly undertake and complete a work program to implement this change in all existing and future equipment purchased under this Contract.

1.2.2 Hardware

Wherever Windows/Intel or compatible computer servers are used, equipment of a single manufacturer shall be proposed and installed, preferably of a single type. Operating system, database management system version levels of all components shall be consistent with the SFMTA's supported system levels.

The Contractor shall submit a complete list of required IT equipment for the Final Design Review **[CDRL12-1-1 IT Equipment List]**. These requirements and specifications may be refined and finalized as part of the Final Design Review. The proposed servers shall have redundant layouts for NIC cards, fans, power supplies and support SAN mass storage. As part of their Proposals, the Qualified Proposers shall describe the proposed method for backup of all databases and repositories **[PRL 12-1-1 Database and Repository backup].**

Tape backup as a physical medium to support the proposed backup methodology is not acceptable. The servers shall be remotely manageable, and be integrated with the Network Management System **(Appendix Twelve (12) Section Four (4) "Network Requirements").**

The Contractor will be responsible for providing all necessary hardware, software, wiring, cables, cable management systems, racking, and power distribution to interconnect all equipment. The Contractor shall install all computer equipment, dispatch center equipment, dispatch consoles, and monitoring consoles required for the MTMS as specified herein. The Contractor shall also install all rack-mounted servers, mounting hardware, and other components necessary for a complete and fully operational MTMS and PSVRN, along with connecting the equipment to existing utilities, the SFMTA, and City and County of San Francisco (CCSF) computer equipment. Rack mounted servers shall be installed whenever and wherever possible. Other server types, such as tower frames, shall be approved on a case-by-case basis, and only where design constraints may dictate their use over rack mount servers.

The Contractor shall conform to applicable local and state safety regulations, procedures and requirements, including statutory requirements. Rack equipment mounting procedures shall prevent damage as a result of seismic activity. This shall also include the construction period and prevent inadvertent damage during construction activities.

As is a requirement for all equipment installed in this project, hardware shall be new, factory built equipment.

1.2.3 Software Rights

The Contractor shall provide a machine-readable copy of all source code, build scripts, installers, and executable files that were developed for the SFMTA. The source code and executables for interfacing the MTMS to other the SFMTA systems that were developed specifically for the SFMTA shall also be provided. The machine-readable, electronic program source code, script and configuration files provided shall contain all the data required to enable the SFMTA to restore, build, reinstall, add, modify, or delete the SFMTA specific applications, displays, reports, and interfaces to other systems. As part of their proposals, the Qualified Proposers shall list the required build tools to create the executable software from source, including, but not limited to, Integrated Development Environments (IDEs), Virtual Machines (VMs), compilers, linkers and debuggers **[PRL 12-1-2 Software Build Tools].**

For the remainder of the Project, the Contractor shall provide an escrow agreement that guarantees the SFMTA access to all files that are required to build the system's target object or VM executable bytecode. The Contractor, as depositor of the escrow files, shall submit all items required to build the system's target object files (executables), including, but not limited to:

- Source files including source code, resource files such as icons and message texts, binary libraries bound against the source code such as libc or .jar files
- Build scripts
- Application framework such as JRE or .NET, as applicable
- Scripts for the execution of the executables
- Build instructions that describe the generation of object files (executables) from the source files and build scripts in escrow.

All source files shall be archived such that the original directory tree structure is automatically restored when extracted.

The Contractor being unwilling or unable to perform future system software/firmware maintenance or modifications required by the SFMTA will meet the conditions to release the items in escrow to the SFMTA. This condition and the release of the item includes the irrevocable and complete transfer of Intellectual Property rights of these items to the SFMTA.

1.2.4 Software Development, Configuration and Customization

The SFMTA expects the use of off-the-shelf software products that will be customized to meet the specific needs and objectives of the SFMTA, and that meet the requirements of the Contract. As part of their proposals, Qualified Proposers shall describe their software development and customization process **[PRL 12-1-3 Software Development/Customization].** This description shall include a description of the Qualified Proposer teams' process of incorporating customizations into future vendor off-the-shelf components or modules, the delineation between configuration and customization, and the Qualified Proposers' configuration change management.

1.3 Design Criteria

1.3.1 Design Criteria and Review

The Contractor shall develop the design criteria of the intermediate design (65%) and final design (100%) of the MTMS and PSVRN, and call a review by the SFMTA to evaluate and review the design criteria in accordance with the schedule outlined in **Appendix Twelve (12) Section Nine (9)**. The review shall include a description of the design criteria and shall verify whether the information is appropriate and complete to meet the scope of the project. The evaluation shall include, but not be limited to, the following elements:

- Understanding of the entire scope of the project
- The design criteria satisfying the scope of work
- Quality engineering practice
- Conformance with APCO and International Homeland Security Task Force recommendations on system interoperability, planning, survivability/redundancy, and security
- Conformance with Federal Transit Administration (FTA) "Transit Security Design Considerations" for the design of radio system and related communication systems, and facility infrastructure
- Reliability, availability, maintainability (RAM).

The Contractor shall capture design criteria review comments and respond to these comments within two (2) weeks. Any changes shall be incorporated into the design criteria. The completed design criteria shall be the basis for the entire design process and shall be used by design engineers during completion of the final design.

1.3.2 Designed System Availability Requirements

All Contractor-provided system hardware and software functionality shall meet defined availability criteria. Combined availability of the MTMS and PSVRN shall be assessed against defined criteria. Combined MTMS and PSVRN availability is a measure of the ability of these systems to provide service at the required levels. Availability is measured as system uptime divided by system uptime plus system downtime.

System availability criteria shall include, but not limited to, the following elements:

- Minimum individual device (hardware) availability.
- Limits on how many failures any individual hardware device may experience (regardless of availability).
- Preventive maintenance
- Mean Time To Repair (MTTR).

Downtime occurs whenever the system functions that are designed to meet the requirements of the Contract are unavailable to the users of the system, including but not limited to “passive” stakeholders such as travelers on the SFMTA’s system or the 511 system. Downtime is measured from failure report until full service is restored. The following events shall include, but are not limited to, events that constitute downtime:

- Repeater site failure of any entire station site
- Site control or site message switching sub-system failure
- Network and backhaul sub-system (contractor-provided equipment only) – failure of network connectivity to one site
- Dispatch sub-system – failure of a dispatch position at each location, including backup control stations
- Vehicle Radio Equipment – failure of on-board equipment, including radio, antenna, control head, microphone, speaker, ancillary equipment and the CAD/AVL interface in 5% of the SFMTA’s combined revenue and non-revenue fleets.

Scheduled maintenance shutdowns, loss of power or environmental controls (where the SFMTA has provided these facilities), failure of the SFMTA and/or CCSF provided equipment, and service response times within specified limits are not considered downtime.

1.3.3 SFMTA CADD Standard

All design drawings submitted to the SFMTA shall meet the SFMTA CADD Standard which will be provided to the Contractor after contract award.

1.3.4 Standards for Design

The Contractor shall identify and adhere to appropriate codes and standards for the design and implementation of the project. Design, maintenance, and performance codes and industry standards for construction and electrical installations are listed in **Appendix Twenty-Six (26), "Codes and Standards".**

- American Concrete Institute (ACI)
- American Waterworks Association (AWWA)
- American Institute of Steel Construction (AISC)
- American Society of Testing Materials (ASTM)
- American National Standards Institute (ANSI)
- National Electric Code (NEC)
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- Sheet Metal and Air Conditioning National Association, Inc. (SMACNA)
- California Department of Transportation (Caltrans)
- Department of Public Works (DPW)
- American Society of Mechanical Engineers (ASME)
- American Welding Society (AWS).

The Contractor shall ensure that applicable, appropriate, reasonable and comprehensive codes and standards are incorporated into all parts of the system design and its design packages.

1.4 Design Review and Design Acceptance Process

The documents and the exhibits of this RFP represent a 35% Preliminary Design. It shall be used as design input to the Contractor's Intermediate Design. Intermediate Design Review (IDR) shall be conducted when the system design is 65%. Final Design Review (FDR) shall be conducted when the system design is 95%. Submittals that are required for the design reviews shall be received by the SFMTA at least fifteen (15) working days before the start of design review. The design review presentations and discussions shall be conducted at the SFMTA's facilities and are expected to be a week in length, but shall continue until all issues are resolved.

Upon Notice To Proceed (NTP), the Contractor shall begin the detailed design of each subsystem, including system interfaces, software systems, radio communications, antenna and transmission lines, power, remote consoles, remote access stations, cabling, wiring, and grounding. As part of their proposals, Qualified Proposers shall describe their design approach, including design criteria **[PRL 12-1-4 Design Approach, Design Criteria].** The following Final Design submittals shall be submitted as corresponding Contract Deliverable Requirements List (CDRL) items **[CDRL 12-1-2 Final Design Submittals]**:

- Overall space and facility layout and design
- Total system functional description
- Software system overview and preliminary design
- Radio System design
- Antenna, multi-coupler, and combiner design
- Dispatcher console layout
- Overall MTMS configuration
- Overall PSVRN
- Communications interfaces
- Network topology
- Power supply, distribution, and loading
- On-board vehicle equipment design, functions, and integration
- System cutover and transition including methods and procedures for all work performed at live sites
- Failure modes, effects, and mitigation
- Hardware and system software requirements the SFMTA provided servers, software, and utility programs
- Environmental considerations, heat loads, ventilation requirements, electrical loads
- System Functional Description

- Software Description Document
- Hardware configuration block diagram showing all Contractor-provided MTMS and PSVRN equipment, including interfaces to other the SFMTA systems, software, and equipment
- Dispatch center and emergency operations center layout plans showing the proper dimensions and locations of the consoles and other MTMS and PSVRN equipment to be installed
- Radio system fixed site designs, including all equipment to be installed at each location, dimensions and locations of the equipment, antenna system designs, and power sources
- Radio system technical data and studies as specified in **Appendix Twelve (12) Section Two (2),** including final radio coverage area calculations and documentation
- Console layout drawings showing the proper dimensions and locations of all Contractor furnished equipment being installed on or in the consoles
- Custom hardware design documents
- Draft MTMS and PSVRN user's manuals that describes the layout and content of all displays, reports, and user actions required to perform each function available to users.
- Communications interface block diagrams
- Network topology diagrams including IP addressing scheme and security features
- On-board vehicle equipment block diagrams, equipment layouts, equipment installation locations and mounting details (for each type of vehicle), on-board equipment interface descriptions, and functional descriptions
- Draft transit operator documentation that provides detailed operating instructions and procedures for each function available to the Transit Operators using the on-board vehicle equipment.
- Installation and phase-over plan
- Failure modes and effects analysis
- For any options purchased, all applicable documents specified above.

Prior written acceptance of the final designs by the SFMTA shall be required before commencing any further work or procurement or manufacture of any equipment.

The Contractor shall also prepare and provide complete installation plans, test plans and procedures, MTMS and PSVRN cutover plans and procedures, training plans and materials, and an integration plan **[CDRL 12-1-3 Installation Plans, Test Plans and Procedures].**

The Contractor shall provide a clear and comprehensive plan to ensure that the SFMTA's staff is effectively trained and comfortable with the operation and use of the dispatch and mobile equipment before MTMS and PSVRN cutover. Expectations and assumptions for the SFMTA furnished materials and support shall be clearly stated. These shall align with the requirements of the Contract.

The Contractor shall incorporate any and all comments received from the SFMTA into the design documentation.

It is understood that the SFMTA's acceptance of designs, including, but not limited to, Final Design, does not relieve the Contractor to any degree from the Contractor's responsibility to meet the requirements of the contract.

1.5 System Security

As part of the final design, the Contractor shall provide a detailed description of the physical and logical security features provided with the MTMS and PSVRN, as described in **Appendix Twelve (12) Section Four (4) "Network Requirements" [CDRL 12-1-4 Physical and Logical Security]**. The Contractor shall agree to support the SFMTA to ensure that network and server security complies with the SFMTA and CCSF policies, practices, procedures and work instructions. Except for new construction, including but not limited to base station shelters, the Contractor will not be required to provide the physical facility security such as locks and fences.

1.6 System Time

The MTMS and PSVRN shall automatically synchronize system time with a coordinated universal time source and propagate time to all system components including mobile and portable units. Daylight savings time switches shall be performed automatically with no user intervention required.

1.7 System Compatibility, Interface and Interoperability Requirements

1.7.1 Equipment Interface Designs

The Contractor shall develop Interface Control Documentation (ICD) describing the physical, mechanical, electrical, software, and functional relationships of equipment being interfaced **[CDRL 12-1-5 Interface Control Documentation (ICD)].** Documentation shall include sufficient detail, enabling the designers of the MTMS and PSVRN to meet the interface requirements while designing each subsystem.

The ICD shall provide all detailed specifications of each interface point, including physical, mechanical, environmental, and electrical specifications, levels, and protocols.

The ICD shall be submitted for design review and acceptance at IDR and FDR.

1.7.2 Software Interface Designs

The Contractor shall be responsible for the design, licensing, and implementation of all MTMS and PSVRN software interfaces to the specified external systems. It shall be the responsibility of the Contractor to determine the interface capabilities of the external systems. Any deficiencies in those interfaces and external system that may prevent full compliance with the functional requirements of this specification shall be reported to the SFMTA.

Software interfaces to external systems shall be fully documented, non-proprietary, and based on recognized standards developed by official standards-making bodies or Committees (e.g. IEEE, SAE, ITF, etc.). In the absence of a recognized standard, external software interfaces shall be fully designed and documented by the Contractor to an extent sufficient for third parties to implement and/or modify the external side of the interface.

The MTMS and/or PSVRN performance shall not be affected by the level of data transfer activity to and from any or all of the external systems.

1.7.3 Enterprise Network Interface

The Contractor shall agree to work with and assist the SFMTA staff to integrate the required MTMS and PSVRN functions into the SFMTA's enterprise. The Contractor shall support and assist in providing recommendations including but not limited to networking security, gateways, remote login, integration of remote sites and enterprise users in planning and reporting and all other areas with needs for access to functions of the MTMS. Further network requirements are described in **Appendix Twelve (12) Section Four (4) "Network Requirements"**.

1.7.4 Interface Change Management

System interfaces shall be managed through reference to the Interface Control Document. In this document, agreed upon changes to interfaces shall be documented and kept current.

1.8 Installation Standards

1.8.1 General Installation Standards

Unless otherwise specified, system installation shall conform to the following general standards:

- Workmanship and appearance of work throughout shall be of the best commercial quality and adhere to the latest edition of all applicable standards and codes
- Work shall be performed only by qualified personnel, and shall be supervised by technically competent, trained, experienced supervisory personnel at all times
- All equipment and components shall be easily accessible for adjustment and service
- Cabling and equipment exposed to the elements shall be adequately protected from wind, rain, and dust. Seals, gaskets, packing, sheathing, finishes, mountings, and all other exposed items shall be designed for maintenance-free performance under long-term exposure to weather, including ultra-violet radiation.
- Equipment and cabling installed inside vehicles shall be adequately protected and routed to avoid mechanical impacts, water and dust, including but not limited to vehicle cleaning operations
- Equipment requiring adjustments shall be securely installed inside vehicles using tamper-proof containers, fasteners, etc. Frequent re-adjustment shall not be required, and if found necessary, considered a factor of fleet defects.
- Conductors shall be continuous between terminals, without splices
- Conductor gauge, insulation, and shielding shall be adequate for the intended purpose
- Cable and wire shall be run neatly, with adequate lacing or clamping
- Consistent cable and wire color coding shall be used, in accordance with standards such as EIA/TIA-586, as applicable
- All applications requiring physical movement and flexing shall use stranded conductors
- Ring-type, crimped lugs shall be used with stranded wires terminated on screw-type terminals. Connections shall be made only with crimping tools that meet the connector manufacturer's specifications.
- Shielded wiring, or other means of signal isolation, shall be used wherever necessary to avoid cross-talk, hum, pops, clicks, whine, and other forms of interference. The Contractor shall resolve any interference issues should these occur.
- Unless installed in conduit, wiring within consoles, beneath raised floors, and from outlet boxes to free-standing or desk-mounted equipment shall be neatly installed, bundled with appropriate tie-wrap devices, and tied to supports if practicable

- Dispatch center signal and control wiring, and connection of devices referenced in this Specification, shall be installed in conduits or concealed, and shall be included as part of the work to be performed by the Contractor. Wiring shall be accessible for maintenance. At remote sites and in equipment rooms, open cabling is permitted on cable racks provided they are neatly tied.
- Interconnect cabling used within consoles, equipment cabinets, or in areas where the wiring will not be installed in metallic conduit, shall be insulated with heat-resistant material to minimize pyrolysis and fire hazard
- Cable and wiring penetrations through metal cabinets shall be insulated with dielectric grommets
- Cable and wiring installed in modular furniture shall be run in the trays or channels designed for that purpose
- Extra wiring necessary for equipment movement shall be neatly coiled, tied, and concealed
- Wiring in dropped ceiling areas shall not lie on top of light fixtures or ceiling tiles
- Cable penetrations through building outside walls shall be thoroughly packed and waterproofed
- Cables, wiring forms, and terminals shall be identified by permanent labels, tags, or other appropriate means. Marking shall clearly indicate the function or source. Cables shall be identified at both ends with indications of the source and destination of that cable run. The cable identification shall agree with the wiring and interconnect diagrams
- Installation at all sites shall be in complete compliance with all applicable building, seismic, and fire codes
- All conduits and cables shall be identified by permanent labels, tags, or other appropriate means.

1.8.2 Rubber-Tired Vehicle Installation Standards and Mobile Installations

The following requirements apply to all mobile radio and ITS equipment to be installed on the SFMTA's vehicles.

All of the SFMTA vehicle installations shall be subject to inspection and quality control before acceptance, by inspection personnel to be named by the SFMTA. The Contractor shall include a vehicle installation and inspection procedure with FDR.

Vehicle Acceptance shall include, but not be limited to:

- Appearance
- Effective usefulness
- Full programming as set forth by specifications and the requirements of the contract
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

Prior to any Contractor testing, the coach electrical supply should be verified as suitable and adequate for proposed equipment requirements. Routing, connections and circuit protection for radio and any onboard equipment connectivity shall be inspected and approved by the SFMTA.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support structure.

Ties to such supports shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle. On vehicles equipped with driver, passenger, and side air bags, the Contractor equipment shall not interfere with deployment. If necessary, the Contractor shall propose and install a passenger side front air bag disabling switch. Modification of any safety equipment or air bags require the SFMTA's approval and shall be performed at the Contractor's expense by a US-DOT certified technician and include registration with the California Department of Motor Vehicles.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

Wiring of the new equipment shall not be connected to existing radio equipment in the vehicle.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

In vehicles that employ electronic sirens, an audio output shall be connected to the siren for effective public address (PA) use through the siren speaker. The SFMTA prefers a design that will utilize a single microphone for both radio communications and PA use.

In vehicles that employ intercom systems, the new equipment shall be connected to the intercom system upon cutover to the new radio system. New radios shall be checked for compatibility with the intercom system at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment, at no additional cost to the SFMTA.

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle, with adequate clearance and ground planes, based on but not limited to performance and interference requirements, and manufacturer specifications.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power, or VSWR, shall be measured and documented after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

No wiring shall be spliced within the loom covering that wire.

"LOK" or "T-Tap" style splice connectors shall not be permitted.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any and all vehicles that experience dormant operation battery drain, where such drain can be attributed to new equipment installation. The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

All statutory and regulatory safety requirements shall be followed at all times. All contractor staff shall be trained and certified to the required safety standards and in accordance with the SFMTA's safety program.

1.8.3 Rail Vehicle Material and Workmanship Standards

Material and workmanship standards for any equipment installed on the SFMTA's fleet of light rail vehicles and historic vehicles are contained in **Appendix Twenty-Two (22).**

1.8.4 Cleaning

All work and supporting areas shall be cleaned no later than at the end of each workday. On an ongoing basis, cleaning shall support installation performance, safety, quality and work standards and be scheduled and performed accordingly.

The Contractor, at the Contractor's expense, shall dispose of all rubbish, and debris, in accordance with all regulatory and statutory requirements applicable to the work site.

1.8.5 Product Identification and Traceability

The Contractor shall develop and maintain an equipment labeling plan that shall allow the identification of products and materials by suitable means throughout the lifecycle of the Radio System Replacement **[CDRL 12-1-6 Equipment Labeling Plan]**. This shall include but not be limited to formal configuration management to support and record the configuration of software components.

1.8.6 Decommissioning and Disposal of Existing Equipment

The Contractor shall provide evidence that all material and electronic waste removed from the SFMTA and CCSF sites has been legally and responsibly disposed of and/or recycled.

1.8.7 Regulatory and Statutory Requirements

All work shall be performed in accordance with applicable environmental, safety and labor related regulatory and City and County of San Francisco and the SFMTA statutory requirements, including but not limited to:.

- APCO and International Homeland Security Task Force recommendations on system interoperability, planning, survivability/redundancy, and security
- Federal Transit Administration (FTA) "Transit Security Design Considerations" for the design of radio system and related communication systems, and facility infrastructure.
- Federal Transit Administration (FTA) QA/QC Guidelines.

1.9 DBI Plan-check Review and Acceptance, Building Permits and DBI Inspection Requirements

Appendix Twenty-Seven (27) contains the SFMTA Permit Process. The Contractor shall follow and meet the requirements of the Permit Process.

1.10 City Planning Process

Please refer to **Appendix Twenty-Seven (27), "San Francisco City Permit Process"**.

1.11 System Redundancy and Availability

1.11.1 Infrastructure Redundancy

Critical components of the voice and data system infrastructure shall be designed with redundancy in order to ensure high system availability. General failover capacity shall be provided along the following lines:

- Subsystem inherent fault tolerance. The proposed subsystems shall provide a level of inherent fault tolerance without single points of failure, distributed processing and hot stand-by equipment configurations, as indicated elsewhere in this specification. All computer servers shall be appropriately redundant or clustered in the proposed design to meet availability requirements. Where redundancy has been designed into the MTMS and PSVRN, failover shall be automatic and transparent to the users of the system. There shall be no loss of operating data during the failover process.
- Vehicle ITS autonomy. In case of communication systems failures or coverage and capacity issues, vehicles ITS function shall be capable of autonomous initialization and operation.
- Mutual data and voice radio network fallback support. Data and voice radio network shall have mutual fallback capability, e.g. messaging fallback.
- Dynamic dispatcher and train controller work assignments in case dispatch and control center locations fail. Although a backup control center may not be requested within the scope of this RFP, backup control center capability shall be provided with the MTMS and PSVRN for future expansion.

The SFMTA requires a trunked LMR system that shall not suffer loss of the trunking capability resulting from the failure of a single system component.

The SFMTA's System Administrators shall be notified and event log entries created in the event of any system disruptions or problems.

1.11.2 Failure Modes

In response to the RFP, the Qualified Proposers shall describe the various fallback modes of operation of their proposed system design, from full system functionality to the least system functionality that will support the SFMTA's communications needs **[PRL 12-1-5 Fallback Modes of Operation]**. Qualified Proposers shall explain the following:

- How their system design is such that the possibility of the SFMTA experiencing a complete failure of radio coverage in the SFMTA's service area is reduced to a minimum.
- Potential single-point failures that will result in a degraded mode of operation.
- How the proposed design will support system reliability requirements for dispatch system facilities with a minimum life expectancy of 10 years from the date of system acceptance.
- Projected system reliability and Mean Time Between Failure (MTBF) for major subsystems and equipment, based on the system proposed.
- How the system will react to a failure of each major system element.
- The impact of failure of any computer server, storage component (disk array, storage area network, etc.), or network equipment **[PRL 12-1-6 Failure Impact].**

For the final system configuration, the Contractor shall provide a Failure Modes and Effects Analysis **[CDRL 12-1-7 Failure Modes and Effects Analysis].**

1.11.3 Radio Coverage

The trunked LMR system shall meet all coverage requirements as specified by the SFMTA.

The coverage of the individual LMR sites shall be designed with the greatest extent of "overlap" of the radio coverage between the various radio sites.

The Contractor shall optimize the cost/performance ratio of utilizing multiple antennas, transmit combiners, and receiver multi-couplers in their site and tower design.

Refer to **Appendix Twelve (12) Section Two (2)** for further information.

1.11.4 Radio Base Site Infrastructure

The Contractor shall be required to provide redundant critical network control equipment at an additional site, interfaced to the main site such that switchover to the backup site will ensure no loss of full functionality over the entire infrastructure. Refer to **Appendix Twelve (12), Section Two (2)** for further information.

Any system component enclosure or power distribution design that could render the system or 25% of its channel resources useless for communications from a single point of failure shall incorporate redundancy. This may be in the form of a redundant component/enclosure or a distributed redundant design that distributes single points of failure among multiple card cages, cabinets, or housings, each operating on its own dedicated power circuit.

In the case of redundant simulcast controllers or multi-site switches, both shall remain on-line continuously with parallel updating of the system database to provide minimal interruption of service in the event of failure of the main controller or switch.

Switching from main to standby operation shall be fully automatic, with audible and visual indication of the switchover provided to the supervisory console position at the Operations Control Center.

1.11.5 Manual Switchover

Remote switching from main trunking controller or wide area switch to the standby trunking controller or wide area switch shall be provided at the supervisory console as a manual override to automatic switchover.

1.11.6 Failure Statistics

Mean Time Between Failures (MTBF)

The Qualified Proposers shall specify the Mean Time Between Failure (MTBF) for all of its major system components for the PSVRN and MTMS. **[PRL 12-1-7 Mean Time Between Failure (MTBF)]**

Mean Time To Repair (MTTR)

The Qualified Proposers shall specify all known Mean Time to Repair (MTTR) data for the major system components for the PSVRN and MTMS. **[PRL 12-1-8 Mean Time to Repair (MTTR)]**

As part of the system design, the Contractor shall use this information when calculating overall system reliability and availability data for its detailed design **[CDRL 12-1-8 System Reliability and Availability Calculation].**

1.11.7 Radio Channel Failure

If a radio channel fails, the system shall permit continued operation of all subscriber units or talk groups originally assigned to that channel. This shall be accomplished by automatic switching of the talk group or subscriber units to another radio channel. This shall apply to either voice or data communications.

Multiple radio channel failures shall sound a major alarm at both the control center and the network manager locations.

1.11.8 Onboard Vehicle Failure

In case of an onboard MTMS data communications failure, the system shall automatically save critical operating data (time point arrival and departures times, passenger counts, and TSP requests) onboard for later upload to the central MTMS. The system shall operate in voice fallback mode. The onboard MTMS shall continue to attempt to re-establish data communications until successful. The voice fallback mode shall provide basic signaling functions to allow participation in trunked voice radio communications, including the signalization of Request to Talk (RTT), Priority Request to Talk (PRTT) and Emergency Alarm (EA) through the vehicle operator controls that are used in regular system operation. On the central side, fallback trunked voice radio and signalization shall be integrated with the console system such that dispatcher control are used that are also used in regular system operation.

Any failures that prevent the preceding conditions to be met shall result in the vehicle considered inoperable and vehicle availability compromised.

1.11.9 System Availability

The combined MTMS and PSVRN systems shall be designed for and meet an overall annual availability of 99.999%. If any part of the radio communications infrastructure, CAD/AVL operation, real-time passenger information system, or database management components of the system fails or requires maintenance and cannot be completely covered by backup equipment, the PSVRN shall be considered unavailable. Based on 99.999% availability requirement, the combined MTMS and PSVRN systems shall be unavailable for no more than 5 minutes per year. Combined MTMS and PSVRN system availability is defined as the availability of at least one of the two system at its full functionality level.

Full operation of the system infrastructure (even if by backup unit) is required to maintain system availability. This requirement assumes that there shall only be limited subsystem failures, and that the SFMTA shall not experience total LMR system failure over the projected life of the system. Total LMR failure shall be construed as meaning a complete loss of the radio communications system with inability to communicate with any subscriber units using voice communications.

MTMS availability is considered compromised if the MTMS equipment is inoperable on more than 5% of the vehicles.

The Contractor shall include its calculated reliability and availability criteria for each equipment component and full system design with site by site detail in its total detailed MTMS and PSVRN design. **[CDRL 12-1-9]**

The SFMTA furnishes parts of the network infrastructure, such as dark fiber links and their termination and the microwave backbone infrastructure. It is understood that the LMR and CAD/AVL systems build on these components. The design and build of the LMR system shall not lead to a total LMR system failure in case one or multiple SFMTA furnished components would fail.

1.12 Expandability

The MTMS and PSVRN shall be sized and contain the capacity to accommodate the SFMTA service expansions such as the Central Subway, without the need for upgrades or changes to the installed system, over the lifetime of the system, except for:

- Growth of subscriber unit numbers as specified in **Appendix Twelve (12), Section Two (2)**
- Expansions to radio coverage
- Wayside equipment such as traveler information or Traffic Signal Priority (TSP) equipment
- Rolling stock installation.

1.13 SFMTA Provided Space and Vehicles

Space for storage and work trailers may be made available, but only on a limited basis, as discussed in **Appendix Twelve (12) Section Eight (8)**. Therefore the Qualified Proposers shall not assume that the SFMTA will provide space for equipment storage, segregation of non-conforming product, work bays, kitting, storage of decommissioned materials, personal lockers any other space needed to perform the required work.

The Qualified Proposers shall note that individual divisions might be constrained in their availability to perform night work. Further, the Qualified Proposers shall not assume that vehicles can be made available for installation, quality control or any other activity during daytime revenue service hours. As part of their proposals, the Qualified Proposers shall demonstrate an understanding and discuss the impact of constraints for construction activity at all of the SFMTA and CCSF sites, including railway tunnels, maintenance facilities, and other sites **[CDRL 12-1-9 Calculated Reliability and Availability Criteria].**

The Contractor shall factor ongoing fleet rehabilitation programs into the project planning.

1.14 National and Regional ITS Architecture Compliance

It is the SFMTA's intent to follow the Intelligent Transportation Systems (ITS) engineering methodologies promulgated by the Federal Transit Administration (FTA). The design and build of the MTMS shall conform to:

- Regional ITS system design standards published by the FTA (http://www.its.dot.gov/standards/index.htm)
- San Francisco Bay Area Regional Intelligent Transportation Systems Plan as published by the Metropolitan Transportation Commission (MTC) (http://www.mtc.ca.gov/planning/ITS/index.htm).
- The Contractor's design implementation shall follow the recommended processes for team members, system integrators, and designers, as defined in the Systems Engineering Guidebook for ITS, Version 2.0, January 2007 (http:// www.fhwa.dot.gov/cadiv/segb/).

1.15 For Reference Only Sections and Appendices

This RFQ/RFP contains a series of technical sections and appendices that are for reference only. The table below lists the reference-only technical sections and appendices:

Appendix or Section	Requirements	
AP 9, Drawings	Required	
AP 10, "Sample Quality Assurance Plan"	For reference only	
AP 12, Section 1 "General Requirements"	Required	
AP 12, Section 2 "Radio Communications Components"	Required	
AP 12, Section 3 "ITS Components"	Required	
AP 12, Section 4 "Network Requirements"	Required	
AP 12, Section 5 "System Installation and Cutover"	Required	
AP 12, Section 6 "Quality Control & Inspection/Quality Assurance"	Required	
AP 12, Section 7 "Testing and System Acceptance"	Required	
AP 12, Section 8 "Training, Support and System Maintenance"	Required	
AP 12, Section 9 "Project Management, Schedule, and Documentation"	Required	
AP 13 Appendix Deleted	N/A	
AP 14 "Dispatch Workstations and Consoles"	For reference only	
AP 15 "Interface Control Document for Onboard Devices and the TransLink® Driver Console"	For reference only	
AP 16 "511.org Travel Information"	For reference only	
AP 17 "Example: Coverage Test Plan"	For reference only	
AP 18 "Radio Licenses"	For reference only	
AP 19 "Traffic Analysis Report"	For reference only	
AP 20 "Existing Underground Communications Drawings"	For reference only	
AP 21 "SFMTA Planned Talk Group Listing"	For reference only	
AP 22 "Rail Vehicle Material and Workmanship"	Required	
AP 23 "Light Rail Vehicle Digital Visual and Audio System Technical Specifications"	Required	
AP 24 Appendix Deleted	N/A	
AP 25 "SFMTA Organization Chart"	For reference only	
AP 26 "Codes and Standards"	Required	

AP 27 “Permit Process”	**For reference only**	
AP 28 “Cost Proposal Form”	**Required**	
AP 29 “Light Rail Vehicle Drawings”	**For reference only**	
AP 30 “Underground Tunnel Clearance Diagrams”	**For reference only**	
AP 31 “SFMTA Surface Stop Shelters with NextBus Displays”	**For reference only**	
AP 32 “Underground passage ways”	**For reference only**	

1.16 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12-1-1 Database and Repository Backup
- PRL 12-1-2 Software Build Tools
- PRL 12-1-3 Software Development and Customization Process
- PRL 12-1-4 Design Approach, Design Criteria
- PRL 12-1-5 Fallback Modes of Operation
- PRL 12-1-6 Failure Impact
- PRL 12-1-7 Mean Time Between Failure (MTBF)
- PRL 12-1-8 Mean Time to Repair (MTTR) Data
- PRL 12-1-9 Understanding of Construction Constraints.

1.17 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-1-1 IT Equipment List
- CDRL 12-1-2 Final Design Submittals
- CDRL 12-1-3 Installation Plans, Test Plans and Procedures
- CDRL 12-1-4 Physical and Logical Security
- CDRL 12-1-5 Interface Control Documentation (ICD)
- CDRL 12-1-6 Equipment Labeling Plan
- CDRL 12-1-7 Failure Modes and Effects Analysis
- CDRL 12-1-8 System Reliability and Availability Calculation
- CDRL 12-1-9 Calculated Reliability and Availability Criteria

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.

appendix **twelve**: section **two**

Radio Communications Components

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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2.0 Radio Communications Components

2.1 Introduction

This section describes the specification requirements for the turn-key implementation of a radio system that shall provide wireless voice and data communications for the San Francisco Metropolitan Transit Agency (SFMTA) and various City and County of San Francisco (CCSF) agencies. This specification document delineates the requirements for the mobile, portable, fixed site and associated network management equipment required to support the Public Service Voice Radio Network (PSVRN), Multimodal Transit Management System (MTMS), and underground radio network requirements.

This section provides a proposed system design that defines the SFMTA and CCSF system and coverage performance requirements. This preliminary design includes the selection of several variables, including, but not limited to, the radio system technology, base station sites, frequency and channel allocations. This design is presented here as a reference for the Qualified Proposer as to the type of radio system envisioned by the SFMTA and CCSF. This design shall be further considered after a contract is awarded to a Qualified Proposer in the context of preliminary and final system designs that are to be completed by the successful Qualified Proposer and approved by the SFMTA. The final design and performance of the system shall be the responsibility of the Contractor.

It is the intent of the SFMTA to construct and implement a radio communications infrastructure that includes the latest service proven technology and that meets, at a minimum, the standard transit and public safety requirements for performance, coverage, and redundancy.

In addition to the primary radio design Proposal, Qualified Proposers are permitted to submit other alternative designs if it can be shown that an alternative provides equivalent or superior functionality. Public networks may be considered only in cases specifically mentioned in this RFP but, not as a viable alternate solution or, as a qualified communication Proposal for voice, radio, and data services.

The SFMTA radio system shall utilize CCSF's existing backhaul communications system. This comprises a combination of microwave and fiber optic systems at each site (**Appendix Twelve (12) Section Four (4)** of this RFP). The Contractor shall use these systems to provide redundant backhaul communications between the various component sites of the system. The Contractor shall coordinate with the SFMTA to assure an integrated system design as discussed in **Appendix Twelve (12) Section Four (4)**.

The radio system implementation will achieve the following goals:

- Optimize the efficient use of the SFMTA frequency's
- Provide a high system availability, reliability and survivability
- Enhance the maintainability of the system,
- Easier process to upgrade system components
- Provide a system which can be easily expandable
- Enhanced coverage that meets the SFMTA service area
- State-of-the-art digital technology
- Open architecture interface(s) to neighboring systems, such as the City and County of San Francisco Department of Emergency Management and other of the SFMTA IT systems
- Communications backbone compatibility with the MTMS as described in this RFP
- Increased system capacity
- Improved operational efficiency and flexibility in communications systems
- Flexibility and simplicity in creating and maintaining multiple talkgroups
- Integration into the regional P25 voice and data core network, when applicable
- Fully integrated radio communications within the existing and the planned SFMTA infrastructure
- Capability to rapidly transition to a back-up control center when available.

2.1.1 Existing Radio System Description

The SFMTA's existing 480 MHz conventional systems are either single site repeaters or are voted and transmitter-steered; the SFMTA security radio is two site simulcast system was installed at 2008. The vast majority of equipment is aging and incapable of meeting the SFMTA's reliability expectations or future spectrum-efficiency requirements. Therefore, they are not considered a viable foundation for the new system. **Appendix Eighteen (18)** provides details concerning the licensed radio system configuration. Licensees and pending applications are available upon request.

The existing systems use leased communications lines for back-haul from each site. System comparators are located at the Operations Control Center (OCC) at 131 Lenox Way in San Francisco.

The multiple distinct radio networks which are currently in use by the SFMTA and the Department of Public Works are:

Exhibit 2.1.1 – 1: Existing City Networks

Existing City Networks			
Radio Network/Channel	**Channel Capacity**	**Frequency Band**	**Network Owner/ FCC License Holder**
Operations/Maintenance	**1 Voice**	**40 MHz**	**SFMTA/CCSF**
Coach, Trolley, Light Rail	**5 Voice-2 Data**	**480 MHz**	**SFMTA/CCSF**
Fare Enforcement and Security Radio System	**1 Voice**	**480 MHz**	**SFMTA Security**
Misc. (low-power use)	**1 Voice**	**480 MHz**	**SFMTA /CCSF**
Cable Car Machinery	**1 Voice**	**800 MHz**	**SFMTA/CCSF**
***DPT (CERS)**	**9 Talkgroups**	**800 MHz**	**CCSF/DTIS, DEMS**
Public Works, Others (PERS)	**46 Talkgroups**	**800 MHz**	**CCSF/DTIS, DEMS**

****While DPT is shown here, they are not part of this project and will remain on current radio network.***

The following tables describe the Above Ground (AG) and Underground (UG) Users in the existing networks in more detail:

Exhibit 2.1.2.-1 Coach, Trolley, and Light Rail Network

			Frequencies		Above Ground /AG Sites				Underground Sites (UG) Sites				
			Base TX	Base RX									
CH	AG Users	UG Users	(MHz)	(MHz)	Mendosa	McLaren Park	B of A	Carl	Church	Eureka	Forest Hill	Montgomery	Civic Center
1/A	Lt. Rail Voice	Lt. Rail Voice	484.6625	487.6625	X	X	X	X	X	X	X	X	X
2/B	Trolley Voice		484.5125	487.5125	X	X	X						
3/D	Trolley Voice		484.6125	487.6125	X	X	X						
4/E	Coach Voice		484.7125	487.7125	X	X	X						
5/G	Coach Voice	Lt. Rail Voice	482.8875	485.8875	X	X	X	X	X	X	X	X	X
6/C	Coach Voice	Lt. Rail Data	484.5625	487.5624	X	X	X	X	X	X	X	X	X
7/F	Coach Voice	Lt. Rail Voice	484.7625	787.7625	X	X	X						

X = Repeater/Base Station BU - Backup Station

Exhibit 2.1.2.-2: Operations and Maintenance Network

			Frequencies		Above Ground (AG) Sites		
			Base TX	Base RX			
CH	AG Users	UG Users	(MHz)	(MHz)	Christmas Tree Point		
1	Operations/Maintenance		31.14	31.14		X	

Exhibit 2.1.2-3: Fare Enforcement and Security Radio System

				Frequencies					
				Base TX	Base RX	Above Ground /AG Sites			
CH		AG Users	UG Users	(MHz)	(MHz)	111 Palo Alto Avenue	One Market Plaza	Christmas Tree Pt	Comm Shop
1	Security	None		483.0375	486.0375	X			
2	Security	None		483.1375	486.1375	X			
3	Security	None		488.5625	491.5625		X	X	X

Exhibit 2.1.2-4: DPT Network (CERS)

		Frequencies		Above Ground (AG) Sites								Underground (UG)
TG	**AG Users**	**Base TX (MHz)**	**Base RX (MHz)**	**Bernal Heights**	**Christmas Tree (CRS)**	**Clay Jones**	**Forest Hill**	**Forth Miley**	**One Market Plaza**	**SFSU**	**South Hill**	**Various**
DPT-A1	PCO Dispatch (PIC 7)	Trunked Radio System Common Frequency Pool 866-869 / 821-824 (23 Channels)		X	X	X	X	X	X	X	X	Radiating Cable Coverage of Various MUNI and BART Platforms and Tunnels (Note 1)
DPT-A2	Admin & Engineering											
DPT-A3	Paint Shop/Traf. Sig. Shop											
DPT-A4	Meter Repair/Sign Shop											
DPT-A5	Special Event											
DPT-A6	Traffic Control Center (Rsrv)											
PD-A11	MUNI, TAC & Co. K											
Scoff	Scofflaw (PIC 6)											
Tow	Tow Dispatch (PIC 5)											

TG - Trunked Talkgroup X - Repeater / Base Station; supports all talkgroups shown.

Exhibit 2.1.2.-5: Cable Car Machinery

			Frequencies		Above Ground (AG) Sites
			Base TX	Base RX	
CH	AG Users	UG Users	(MHz)	(MHz)	Clay Jones
1	Cable Car Machinery	NONE	855.2375	810.2375	X

The Existing Public Works Emergency Radio System (PERS) network is an 9-channel, four-site Motorola SmartNet II 800 MHz simulcast trunked radio system which supports approximately 2100 non-public-safety users on 46 talkgroups, as illustrated below. This system is not Project 25 compatible. The PERS simulcast controller and comparators (Prime Site) is located at the City's Fort Miley/VA radio site. Its trunked controller is located at the CRS site. This controller is shared with the City Emergency Radio System (CERS) trunked public safety network. PERS users will be migrating to the new PSVRN as the subscriber equipment is replaced.

Exhibit 2.1.2-6: PERS Radio Network

			Frequencies						
			Base TX	Base RX	Above Ground /AG Sites				Underground / UG Sites
TG	AG Users		(MHz)	(MHz)	Twin Peaks	One Market Plaza	Fort Miley	South Hill	Various
Qty 5	Dept. of Public Health		`Trunked Radio System Common Frequency Pool 866-869/821-824 (11 Ch)		X	X	X	X	Radiating Cable Coverage of various MUNI and BART Platforms and Tunnels
Qty 22	Dept. of Public Works								
Qty 15	Miscellaneous								
Qty 4	Unified School District								

TG - Trunked Talk Group X - Repeater Base Station: supports all talkgroups shown

2.1.2 Existing Operations

Currently, all of the SFMTA fixed-route radio dispatching operations are managed from the OCC. The operation utilizes ten (10) dispatch workstations with the radio system electronics in an adjacent Radio Equipment Room. In addition, a relatively new voice-logging recorder is located at the OCC for recording all radio channels and workstation voice communications.

Eight (8) Motorola Metrocom consoles with monochrome terminals are installed at the OCC. The consoles connect to a Motorola TDS-2500 system, which is no longer supported by the vendor. The system performs Computer Aided Dispatch (CAD) functions by managing voice radio channel traffic on closed channels, including relaying messages from the mobile radio communications terminals installed on transit vehicles to the dispatch consoles.

The messages include, but are not limited to:

- Routine Calls (Request to Talk – RTT)
- Priority Calls (Priority Request to Talk – PRTT)
- Silent Emergency Alarm (EA)
- S1- S5 SFMTA-definable messages.

The operational use of these messages is governed by the OCC Communications procedure. The Metrocom system also receives vehicle operator logon by line/run number. Each control head is identified by a fixed ID.

The Metrocom consoles are integrated with Motorola Centracom analog radio consoles.

Exhibit 2.1.2 – 1: Existing Radio console configurations.

Existing Radio Console Configurations		
Console #	**Normal Channel**	**Additional Channels**
0	**5**	**1 above and below ground, 2, 3,4, low band**
1	**1 (primary)**	**4, 5, low band**
2	**2**	**3, 4, 5, low band**
3	**3**	**2, 4, 5, low band**
4	**Low band**	**1 above ground, 2, 3, 4, 5**
5	**4**	**2, 3, 5, low band**
6	**Backup**	**1 above and below ground, 2, 3, 4, 5, low band**
7	**1 (secondary)**	**2, 3, 4, 5, low band**

Console 1 is the primary console for Channel 1, with Console 7 serving as a secondary console. The backup Console 6 can be used if one of the other consoles fails, or in similar circumstances.

Channels have been allocated to Muni operations departments as shown in Exhibit 2.1.1-2.

Exhibit 2.1.1 – 2: Existing Radio Channel Usage

Existing Radio Channel Usage	
Channel	**Usage**
1	**Metro Division Equipment, Maintenance Support, Subway Support Crews, Inspectors**
2	**Presidio Division lines, Cable Cars, Maintenance Support, Inspectors**
3	**Potrero Division lines**
4	**Woods and Kirkland Divisions (selected lines)**
5	**Flynn, Kirkland, and Woods Divisions (selected lines)**
Low band	**Non-revenue vehicles/support units**

The Centracom consoles allow dispatchers to dynamically select and unselect incoming voice radio channel audio. A monitor button activates listening into a selected channel, and a red transmit button opens the voice path to the selected transmitter and controls transmitter keying. There are manual site select buttons which override voting and transmitter steering.

Incoming calls through voice channel signaling (which is outside of the data radio messaging in the Metrocom system) are indicated by a call light on the Centracom consoles. This is the case for incoming calls from inspectors and support vehicles which are not equipped with mobile radio communications terminals. Such calls are answered using the call Push-To-Talk (PTT) button in order to generate the continuous coded squelch (PL) tone to open the mobile or portable squelch gate. It can also be used to manually call a transit vehicle which has a mobile radio communications terminal; this switches the voice path to the radio speakers on the transit vehicle, as opposed to the operator handset. The dispatchers and train operators have been instructed to make calls to the operator handset, using the transmit PTT button, as opposed to calls to overhead speakers through the call PTT button. The *Alert* button can be used to generate an audio tone on voice channels. In addition to the transmit button, a foot switch has been installed.

The vehicles in the SFMTA fleet are as listed in **Appendix Twenty Eight (28) "Cost Proposal".**

2.1.3 Existing Underground Network

The existing underground infrastructure consists of thousand's (1000's) of feet of leaky coax which is in poor condition. Scattered amplifiers near the six (6) Master and Slave BDA locations feed and amplify the T-Band signal through the leaky coax. The system has been determined to have a number of coverage and operational deficiencies and interference issues.

The SFMTA underground is supported by multiple base station sites feeding radiating cable through the tunnels. The lengths of the tunnels are found in the reference drawings in **Appendix Twenty (20) "Existing Underground Communications Drawings".**

A bi-directional amplifier exists at one station. All underground base and repeater stations transmit simultaneously on each channel, but are not synchronized together or with the above-ground stations on the same channel. As a result, significant interference occurs at portals and around the intersection of two radiating cable feeds.

Each of the underground repeaters connects with Central Control via the SFMTA analog telephone circuits. The Remote terminal Units (RTUs) utilized leased analog circuits. Station receivers connect to a receiver multicoupler. Each transmitter connects to a transmitter combiner. The combiner and multicoupler output/input ports then connects to the primary, two-way (three port) RF power splitter. At stations with single bores, radiating cables connect to each splitter port and are routed down the tunnels in each direction. Two-bore stations use a secondary RF power splitter, resulting in four ports and four radiating cables. The repeaters, RTU and multicoupler are connected to backup batteries present at each site.

The Embarcadero station is served by a bi-directional amplifier (BDA) system. This BDA supports this station and the Muni turnaround. It connects to radiating cables originating at the Montgomery Station, amplifies all signals (in both directions) to support additional radiating cable.

Due to the close frequency spacing at 480 MHz, significant filtering is necessary on either side of the amplifier. These filters are housed in large cabinets. This isolates signals flowing in opposite directions and reduces mutual-interference.

Due to the extreme filtering requirements, these cabinets use considerable space, and may not be any more space efficient than using a set of three repeaters and their associated antenna combiners and multicouplers. However, the main benefit of using a BDA in this application is that it eliminates signal overlap distortion that would have normally occurred between the Montgomery and Embarcadero stations; this is a common problem through the rest of the underground system. Using a single RF signal source (Montgomery) eliminates RF frequency differences, and minimizes audio bulk delay and audio (spectral) group delay, which can cause this distortion.

2.2 Statement of Work

2.2.1 System Design

The Contractor shall design, furnish, and install a turn-key voice and data radio communications system required to implement the PSVRN and MTMS described in **Appendix Twelve (12), Section Three (3) "Intelligent Transportation System Components"** and to fully comply with the system performance requirements.

This document provides a proposed system design for the radio communications components for the PSVRN and MTMS. Qualified Proposer's are encouraged to propose alternate designs as deemed necessary.

The drawings in **Appendix Nine (9)** depict the existing conditions at the radio sites and vehicles.

The Contractor shall supply a radio system that is capable of providing the following functions:

- Trunked Phase II, P25 functional system
- Phase II, P25 TDMA
- Trunked voice communications for the SFMTA transit users and other CCSF users
- Proven integrated transit voice and data communications for the MTMS
- Fully P25 operational dispatch consoles at the OCC
- Geographically redundant prime site controller system controllers and console controllers
- Interoperability with other City, County and State government and public service agencies
- Supply other City, County and State government and public service agencies that decide to supply other CCSF departments that decide to purchase equipment off of this contract with RF desktop stations or wire-line remote operator position(s) for dispatch operations at their own facilities and any other contract related components.
- Provide radio communication services to the SFMTA Security.

Upon delivery, the system shall be designed and equipped to include six (6) 800 MHz and nine (9) 700 MHz channels to support the MTMS and PSVRN. The 700MHz channels shall be used for voice applications. The 800 MHz channels shall be used for data or voice applications. The APCO Region 6 700 MHz committee has determined that the 700MHz band shall be used strictly for voice operations.

The system shall also be designed and installed to be immediately expandable to nine (9) additional 700 MHz channels which shall be used to accommodate the additional CCSF users in the PSVRN. The design shall only include, at a minimum, wired and configured racks/cabinets, additional ports for the multi-coupler, and combiner space. The installation of the additional infrastructure components, such as base stations, comparator sizing, and professional services for setup/installation has been identified individually as line items in the Cost Proposal Form. These nine (9) channels shall not be counted as part of the 25% growth. The 25% growth shall be based on eighteen (18) 700MHz and six (6) 800MHz channels.

The system shall be designed for a 25% growth. The Contractor shall design the system to allow for an upgrade path to meet this growth requirement. Growth is defined as providing the necessary rack and floor space for the installation of any necessary equipment required for the expansion.

The Contractor's design shall identify space in a rack of similar kind of equipment. The growth calculation shall not be the summation of all available rack space in the initial implementation. Growth shall be calculated based on the space need to expand to the 25% growth figure.

The Qualified Proposer shall describe how they will meet the required growth **[CDRL 12-2-1 System Growth Plan]**. This expansion will accommodate growth in, at a minimum:

- Channels
- System
- Fleet size.

2.2.2 Cost Proposal Form Configurations

Qualified Proposer's must submit a Cost Proposal that includes the MTMS and PSVRN, along with a Deductive Alternate removing the PSVRN and P-25 components. This is shown in **Appendix Twenty Eight (28) "Cost Proposal Form"**.

For purposes of developing the Cost Proposal, the combined MTMS and PSVRN system listed in the Cost Proposal shall have:

- Six (6) 800 MHz MTMS data/voice channels
- Nine (9) 700 MHz P-25 compliant PSVRN transit voice channels
- Nine (9) 700 MHz P-25 compliant PSVRN voice channels for use by the City.

2.2.3 Use of Additional or Alternate Sites

Qualified Proposer's may submit a "Deductive Alternate (Site)" for fewer sites or alternative sites. Alternatively, Qualified Proposers may select additional sites if the coverage cannot be guaranteed with the existing five (5) sites. The Qualified Proposer shall provide, at a minimum, the following information to justify the new site(s):

- Detailed site information
- Any site improvements that may be required
- Any associated recurring cost
- Anticipated non-recurring cost
- Justification for selecting the radio site.

In such case, the Qualified Proposer should provide the results of its preliminary investigation to ensure that The SFMTA's licensed frequencies can be licensed at the alternative sites. Regardless of the number and locations of the sites proposed in the Qualified Proposer's Proposal, the Contractor shall be responsible for the actual performance, including coverage performance, of the system supplied, and shall be responsible for ensuring that the supplied system fully complies with this specification.

Qualified Proposer's project schedule based upon the Qualified Proposer's experience shall reflect any anticipated need for different or additional radio sites to meet the coverage requirements specified herein.

2.2.4 Site Selection

The Proposal shall include system coverage maps showing both mobile voice, mobile data and portable talk-in coverage for each of the proposed five (5) sites. The coverage maps shall , at a minimum, provide:

- The area coverage percentage provided
- The receive sensitivity used in the calculation
- The body loss value used in the calculation.

Any proposed design deviation from the previously listed sites shall be justified in portable, voice, and mobile data coverage maps.

Radio Sites

The SFMTA has identified (5) five sites that the Contractor shall use in designing the system. :

The communication sites:

Bernal Heights

- Lat/Long: N37°44'35.10, W122°24'54.00
- Tower Height: 70.9 Ft AGL

Forest Hill

- Lat/Long: N37°44'55.00, W122°27'59.00
- Tower Height: 86.9 Ft AGL

One Market Plaza

- Lat/Long: N37°47'36.12, W122°23'39.66
- Tower Height: 589.9 Ft AGL

South Hill

- Lat/Long: N37°42'14.00, W122°25'45.00
- Tower Height: 40.0 Ft AGL

CRS Twin Peaks

- Lat/Long: N37°45'16.74, W122°26'47.88
- Tower Height: 190 ft AGL

Clay/Jones (potential alternative/additional site, currently intended for cable car machinery maintenance operations)

- Lat/Long: N37°47'35.04, W122°24'50.94

The **Operations Control Center** control point sites include:

- 131 Lenox Way, San Francisco
- One (1) South Van Ness, San Francisco.

2.2.5 Drawings

The thirty-five (35%) percent preliminary engineering drawings are included in **Appendix Nine (9).** The Contractor may, but is not required, to use these drawings as a basis for the 100% drawings. The Contractor shall be responsible for advancing these drawings to one-hundred(100%) percent for construction and permitting.

2.2.6 Propagation Analysis

Appendix Nine (9) includes site propagation maps for each of the SFMTA selected sites. This analysis utilizes parameters for portable talk–in. The Contractor shall be responsible to meet the coverage requirements as established in this RFP. It shall be the Contractor's responsibility to design, procure, and install all equipment necessary to meet the coverage requirements for any changes made after Contract award.

As part of the Proposal, Qualified Proposer's shall submit the following coverage maps **[PRL 12-2-1 Coverage Maps]**:

- Portable voice, talk-in for each site
- Portable voice, talk-in for the system
- Portable voice, talk-in, in vehicle for each underground tunnel
- Portable voice, talk-in, in vehicle for each SFMTA identified street tunnel
- Mobile data, talk-in for each site.

2.2.7 Interference Analysis

The Contractor shall conduct an intermodulation analysis for each radio site to determine potential intermodulation products (IM study) and provide the proper equipment to protect the SFMTA, CCSF, and others at the site from intermodulation interference **[CDRL 12-2-2: Intermodulation Analysis]**. The study shall consider all appropriate site transmitters, the SFMTA receivers, and CCSF receivers.

The Contractor shall be responsible for its resolution if the equipment supplied under this contract is found to be the source of such interference at any site. If the Contractor's equipment is limited to contributing to such interference, the Contractor shall assist with identifying the source of its contribution and make all necessary changes or modifications to reduce its susceptibility and impact.

Interference in this case is defined as a degradation of effective receiver performance by 1 dB or greater. Interference includes Passive Intermodulation (PIM) interference, which must be kept 10 dB below the noise floor of all co-located receivers.

The Contractor shall provide an interference analysis at the tunnel portals and air vent openings in the tunnels **[CDRL 12-2-3: Tunnel Interference Analysis]**.

The Contractor shall provide a Time Domain Interference Analysis for the system. **[CDRL 12-2-4: Time Domain Interference analysis for the system]**

2.2.8 Radio Traffic Analysis

A traffic analysis report was performed on the existing system in 2008. This analysis was used to determine preliminary voice and data loading. This report confirmed that nine (9) 700 MHz and five (5) 800 MHz channels were the minimum number of channels required for the expected grade of service. Please refer to **Appendix Nineteen (19), "Radio Traffic Analysis Report",** for additional information.

The Grade Of Service (GOS) shall be defined as:

> the probability that an arbitrary call shall complete in less than 1.25 seconds, 99.9% of the time during busy hours:
>
> $P(t_{access} < 1.25s) \geq 99.9\%$
>
> where t_{access} includes time in queue (e.g., 0.5s) and system access time (e.g., 0.75s.)

The Contractor shall be responsible for the GOS of the system. As such, Qualified Proposers shall review the 2008 traffic study report. If, after this review, they do not concur with the results from the 2008 report, the Qualified Proposer shall provide alternatives to achieve the specified GOS. The Contractor shall provide the assumptions made as part of their air-time analysis **[CDRL 12-2-5 Air Time Traffic Analysis Report]**. These assumptions shall include mean call duration and call arrival rate for all call types, percentage of each call type, and drop time (of message trunking used).

2.3 Radio System Performance Requirements

This section includes the system performance requirements for a new 700/800 MHz radio system to provide radio communications for the SFMTA and other City and County of San Francisco users within the defined service area. The requirements covered include:

- System availability
- Reliability
- Interference
- Malfunctions
- Coverage requirements
- Site selection requirements.

The acceptance testing required to demonstrate compliance with the performance requirements are discussed in **Appendix Twelve (12) Section Seven (7) "Testing and System Acceptance"**.

2.3.1 Radio System Availability

System availability criteria is discussed in **Appendix Twelve (12) Section One (1), "General Requirements".**

2.3.2 System Unavailability

System unavailability criteria is defined in **Appendix Twelve (12) Section One (1), "General Requirements".**

2.3.3 Network Access Reliability

Network access reliability refers to likelihood that a subscriber will gain network access for:

- Subscriber registration to the system
- An individual voice or data message, in a specified period of time, in an environment with no message contention and having reliable signal strength.

It is intended to verify basic network reliability and performance, including the effects of simulcast (if applicable) on access. The successful system design shall have a system registration interval of less than 2 seconds, in 99% of attempts. No less than 0.01% of voice message access shall exceed one second from initiation of a push-to-talk.

This performance applies to all subscriber and dispatch workstation equipment supplied.

If the SFMTA experiences network access reliability problems, the Contractor shall perform statistically-valid tests to verify the network meets these requirements at no cost to the SFMTA. The Contractor shall be responsible for correcting the problem at no cost to the SFMTA, if such performance problems contribute in a significant way to delays in final system acceptance,.

2.3.4 Nuisance Malfunctions and Failures

Nuisance problems are recurring operational or functional problems that cause systems or equipment that do not provide the degree of reliability necessary for the SFMTA operations. These types of failures shall not cause the SFMTA to assign significant resources (the SFMTA or staff) to resolve on three or more occasions, on similar models of equipment. Such problems may not reach a formal unavailability threshold described
in **Appendix Twelve (12) Section One (1), "General Requirements".**

Nuisance problems can be caused by software, firmware, or hardware that is faulty or improperly engineered, manufactured or installed.

The Contractor shall be responsible for resolving nuisance problems promptly and at no cost to the SFMTA.

2.3.5 System Failure Modes

Upon failure of the control channel at a site, if appropriate, the system shall automatically reassign the control function to another radio channel. The system shall restore normal operation at the site within two (2) seconds. If a control channel is not utilized as part of the system architecture, the same reassigning of the control function within ten (10) seconds is required.

In the event a portion of the system at a repeater site fails (for example, a voice or data channel repeater transmitter or receiver), the network management system (NMS) shall detect and alarm the failure. The network management shall notify the maintenance and radio dispatcher workstations within ten (10) seconds. The NMS shall not select a defective channel for use, but shall continue to assign traffic to the remaining operating channels.

The system shall provide continued operation in trunking mode upon failure of a remote site Controller or the radio network controller. The Contractor shall furnish a redundant radio network controller, installed at a geographically diverse location, to meet these failure mode operational requirements. The Contractor shall design the system to prevent any single point catastrophic failure of the system or any site.

The Contractor shall design the system for continued operation if the trunking component should fail. This continued operation may be a conventional fallback mode in the event of such failure. For operation in the conventional mode, mobile and portable units shall be pre-programmed to designated channels, and the control stations shall have direct access to predetermined channels.

The Contractor shall provide redundant servers that meet the following failure mode operation requirements:

- Catastrophic failure of the structure that houses the controller and associated equipment due to fire or earthquake or some other failure mode.
- Failure of the signaling and control system that causes a complete loss of trunking capabilities. The system shall provide, within one minute, an indication in all radio units, at the NMS, and at all dispatcher stations of the failure of trunking. In this event, the system shall automatically switch all elements of the system to conventional mode of operation.
- All processors, devices, and on-line and background functions in the SFMTA radio system shall be monitored for fatal and recoverable errors. All errors shall be recorded for later review by maintenance personnel and shall be included in the error statistics displays and reports provided by the system manager's software. Each type of error for each device (for example memory access violation, device reply time-out, or message checksum error) shall be recorded separately and stored for diagnostic review.

Qualified Proposers shall explain the following **[PRL 12-2-2 Failsoft Operation Description]**:

- What failsoft operation is
- How the system can fall into failsoft operation
- What impact failsoft operation has on the subscribers.

Qualified Proposers shall explain the various fallback modes of operation of the proposed system design, from full system functionality to the least system functionality that will support the SFMTA's communications needs **[PRL 12-2-3 Failure Scenario Descriptions]**. Explain how the system design is such that the possibility of the SFMTA experiencing a complete failure of radio coverage in any part of the SFMTA system is reduced to a minimum. Respond to, at least, the following failure scenarios and explain how the system design mitigates these failures. Also explain the impact that each failure would have at the site level, simulcast zone level and system level.

- Lightning Damage at the Site - describe the impact that a lightning strike would have on the tower top amplifier, the antenna, RF transmission line and base station.
- Site Problems - describe the impact of the following:
  - a failed base station(s), a multicoupler or combiner failure.
  - failure of the site controller to the functioning of the site and overall system.
  - failure of the multiplexer supporting the simulcast system, GPS timing failure, or if the simulcast control fails.
  - failure of the control channel.
- Network Management Failure:
  - failure of power at the site and at the cabinet level to the network management equipment.
  - failure of modules or sub-component for the audio and control connections to the sites, logging recorders and dispatch consoles.
  - failure of the system controller.
- Simulcast Components - Describe the impact of the failure of any one or all of the following components/modules: common control, T1 delay, synch, resynch and GPS timing distribution.
- Geographic Redundancy - Describe how your system design integrates geographic diversity to minimize downtime due to catastrophic failure of a site or equipment room.

Qualified Proposers shall explain the back-up power system will operate at the sites and control centers and under what conditions will the designed back-up system be activated **[PRL 12-2-4 Backup Power Systems Description]**.

The Contractor shall provide a complete description and failure modes analysis for the LMR systems supporting the MTMS and PSVRN **[CDRL 12-2-6 Failure Modes Analysis]**.

2.3.6 Radio Propagation Coverage Requirements

The following section defines the coverage performance requirements for the radio system. These requirements shall be verified by the Coverage Acceptance Test Plan (CATP). An example CATP can be reviewed in **Appendix Seventeen (17) "Example Coverage Test Plan"**. The Contractor and the SFMTA shall finalize the CATP for a contract deliverable.

Qualified Proposers shall provide their coverage models based on the five (5) sites identified in **Appendix Nine (9)** and the underground areas described in **Appendix Twenty (20) [PRL 12-2-5 Coverage Maps]**. Along with the coverage maps, Qualified Proposers shall discuss the following issues:

- The coverage tool used to determine the aboveground models
- The coverage tool used to determine the below ground models
- Define the following values used in the coverage prediction models:
    - Transmit antenna height per site
    - Receive antenna height per site
    - Land use and land clutter values
    - Body loss
    - ERP per site
    - Antenna types that were used
    - Antenna down-tilt used
    - Minimum receive signal to achieve DAQ 3.4/BER <2%
    - Mobile antenna height
    - Portable antenna height.

Critical Locations

Certain locations shall be considered critical to the SFMTA's operations and must be included within the mobile data coverage, underground voice/data coverage, and portable service coverage areas described below. The locations include:

1. The complete length of Market Street Tunnel including the following stations:
    - Embarcadero station concourse (mezzanine) and platform levels
    - Montgomery station concourse (mezzanine) and platform levels
    - Powell station concourse (mezzanine) and platform levels
    - Civic Center station concourse (mezzanine) and platform levels
    - Van Ness station concourse (mezzanine) and platform levels
    - Church Street station concourse (mezzanine) and platform levels
    - Castro Street station concourse (mezzanine) and platform levels
    - All Market Street Tunnel crossovers
2. The complete length of Twin Peaks Tunnel including the following stations:
    - Forest Hill station concourse (mezzanine) and platform levels
    - West Portal station platform level and Portal
    - All Twin Peaks Tunnel crossovers
    - West Portal Avenue between Sloat and Ulloa
3. The complete length of Sunset Tunnel and Portal
4. The complete length of Stockton Tunnel
5. The complete length of Broadway Tunnel
6. The complete length of Mac Arthur Tunnel
7. The complete length of Yerba Buena Tunnel
8. Cable car routes and cable car machinery sheave pits throughout the cable car service area as follows:
    - Sheave pit at Eddy and Powell (approx. 2 Powell St)
    - Sheave pit as Washington and Powell (approx. 1090 Powell)
    - Sheave pit at Bay and Taylor (approx. 2490 Taylor)
    - Sheave pit at Van Ness and California (approx. 1690 California St)
    - Sheave pit at Hyde and California (approx. 1390 California St)
    - Sheave pit at Mason and California (approx. 992 California St)

- Sheave pit at Drumm and California (approx. 2 California St)
- Sheave pit at Pacific and Hyde (approx. 1577 Hyde St)
- Sheave pit at Beach and Hyde (approx. 2824 Hyde St)
- Sheave pit at Victoria Park (approx. 2897 Victory Park)
- Cable car barn (in-building coverage)

9. Presidio Division and yard
10. Potrero Division and yard
11. Woods Division and yard
12. Kirkland Division and yard
13. Flynn Division and yard
14. Green / Geneva Division and yard
15. Muni Metro East and yard
16. Islais Creek Facility and yard (planned)
17. Scott Facility for Non-revenue vehicles
18. Duboce Portal
19. Ferry Portal
20. Eureka Portal
21. Muni Metro Turnaround
22. Justin Herman Vent Shaft
23. 4th Street Bridge, 150 feet southeast of the 4th Street and King Platform
24. Islais Creek Bridge, 400 feet south of the Marin Street Platform
25. Park Merced apartments for Line # 88 and Line # 17
26. 4th Street and King Street
27. Transbay Terminal
28. 19th Avenue at San Francisco State University.

Land Mobile Radio Service Area

The coverage service area reliability is the probability of achieving the desired delivered audio quality (DAQ) and Bit Error Rate (BER) over the defined service area (reference TIA/EIA/TSB88-A-1).

The Contractor shall provide balanced radio coverage that includes 95% of the service area, thus providing the high probability to communicate in all locations. The coverage service area is defined as the jurisdictional boundary of City and County of San Francisco (see **Appendix Nine (9)**)

The coverage service area for portable and mobile data are the same.

The required SFMTA service area generally corresponds to the SFMTA service territory, with some exceptions.

There are three (3) main categories of coverage requirements within the service area: mobile data coverage service area, underground voice/data service area and portable outdoor coverage service requirements.

The following sections define the coverage requirements for each category.

Mobile Data Coverage Service Area Reliability

The Contractor shall design and implement a system that provides a balanced talk-back mobile data outdoor coverage with a 95% service area reliability at 2% Bit-Error-Rate (BER) (reference TIA/EIA/TSB88-C) or better throughout the mobile coverage service area.

Data coverage shall be based on a 95% MSR (Message Success Rate), with one retry. A successful message is defined as having error-free header/routing and payload information, or can be correctable to be error-free, as far as the messaging system is concerned on data channels, based on the fleet polling rate required.

Underground Voice/Data Coverage Service Area Reliability

The Contractor shall design and implement a system that provides a talk-back mobile data coverage with a 97% service area reliability at 2% Bit-Error-Rate (reference TIA/EIA/TSB88-C) or better throughout the mobile coverage service area.

Data coverage shall be based on a 97% MSR (Message Success Rate), with one retry. A successful message is defined as having error-free header/routing and payload information, or can be correctable to be error-free, as far as the messaging system is concerned on data channels, based on the fleet polling rate required.

The Contractor shall design the system to minimize, to the greatest extent possible, any Time Domain Interference (TDI) at the portals to the tunnels and at the vent openings to the underground tunnel.

Portable Service Coverage Area Reliability

Two categories of coverage exist within the service area:

- The Contractor shall design and implement for a balanced (talk-out equals talk-back) outdoor portable coverage with 95% service area reliability with the portable at hip 3.4 DAQ (reference TIA/EIA/TSB88-A) or better throughout the service coverage area.
- 95% coverage reliability over 95% of the service area, for outdoor and underground portable radios, based on one-half wave (~6") antenna at hip level for talk-in and talk-out, for trunked voice.
- The Contractor shall design for balanced indoor portable coverage in the underground areas of the service area used by the SFMTA and CCSF staff. The Contractor shall design the system with 95% Area Reliability with portable at hip at 3.4 DAQ (reference TIA/EIA/TSB88-A) or better.
- In-vehicle attenuation value shall be 10 dB. However, the Contractor may offer to perform statistically-valid measurements to obtain actual median vehicle attenuation values for the final design. This testing methodology and attenuation value must be approved by the SFMTA. However, Proposal coverage guarantees shall be based on not less than 10 dB.
- 95% coverage reliability over 95% of Cable Car routes and 95% of all cable car machinery subterranean areas, for users in a standing position, based on one-half wave (~6") antennas at hip level.

The Contractor shall use a body loss of 12.4 dB at the hip and 9 dB for at the head loss power calculations.

Coverage Service Area Calculation and Documentation

The Contractor shall provide radio coverage predictions using a radio wave propagation model as recommended in the TIA/EIA-TSB88. The Contractor's radio wave propagation model shall be subject to SFMTA approval. If multiple models are used to generate a composite prediction, then a detailed explanation shall also be included.

The Contractor shall take into account terrain irregularity, foliage, urban clutter, noise, and long- and short-term signal variations. The Contractor shall quantify the digitized land use/land cover (LULC) database used for the predictions, including the metadata for the terrain and LULC (i.e., resolution, projection, date, etc.). If there are any areas included in the coverage model that uses terrain data or LULC data that is "digitized" at different levels (e.g. a portion of the CCSF contains 100-meter data while the rest of the county contains 30-meter data), then the Contractor shall indicate such variances.

The Contractor shall incorporate as part of the RF coverage predictions regional frequency plans that outline rules affecting RF coverage in the areas of frequency allocation, effective radiated power, channel spacing, channel bandwidth, and other spectrum related parameters.

The Contractor shall provide a complete listing of all site, component, and system parameters used to calculate and generate the predicted RF coverage. These include, but are not limited to the following:

- Link budget and system loss/gain figures for each proposed RF site by supplying a table or drawing listing all relevant parameters
- System gains
- System losses
- Signal strength
- Receiver sensitivity assumptions.

The Contractor shall indicate if the design includes a handover threshold for RF site switching as part of the system design, referenced in dBm.

The Contractor shall provide prediction maps indicating the sought coverage requirements. The Contractor shall provide individual prediction maps for each proposed RF base site location highlighting mobile data and portable coverage requirements. The Contractor shall provide a composite prediction map for the complete service area indicating all associated coverage requirements. The Contractor shall provide composite prediction maps for the interoperability system indicating associated coverage requirements.

Prediction maps shall indicate county borders, including adjacent counties, RF base site location(s) and Time Domain Interference (if applicable). The Contractor shall provide a graphical representation of the areas that fall below the radio coverage requirements on the coverage prediction maps.

The Contractor shall provide at least one set of RF coverage prediction maps at a scale of at least 1:250,000. The maps shall depict individual sites, non-simulcast sites, a simulcast composite map and an interoperability coverage composite (as applicable). These maps shall be used as reference documentation. The SFMTA requires maps that show sufficient detail to allow for the identification of known landmarks (i.e. road intersections or rivers). The RF coverage prediction maps shall include a legend highlighting all information represented on the map. The Contractor shall include coverage prediction maps depicting coverage that would result if an event caused any (each) of the transmit/receive sites to be destroyed.

Coverage maps shall be provided using the SFMTA's base map and overlaying the coverage plots to produce the coverage maps. These maps shall be provided in a scale and resolution such that all areas with reliabilities less that that required as clearly shown.

The SFMTA has identified problem areas where coverage is deficient and improvement is required. Such areas include, but are not limited to, the area near the Park Merced Apartments, West Portal Station, 4th and King, Castro Station/Eureka Portal, Van Ness crossover, Muni Metro turn-back Vent Shaft, Ferry Portal, West end of Sunset Tunnel, Church and Duboce, Transbay Terminal, Cole (Sunset Tunnel), Sunset (most areas), and 19th Avenue at San Francisco State University.

All coverage guarantees and field coverage verification/acceptance testing shall be based on the guaranteed vehicle radio specifications (not typical specifications), such as shown in equipment technical cut sheets. This coverage criterion is applicable for talk-out (base-to-mobile; downlink) and talk-in (mobile-to-base; uplink), for all channels provided by the Contractor.

Radio Coverage Outside of the Service Area

The SFMTA operates routes in several areas not shown as part of the Service Area illustrated in **Appendix Nine (9), "Drawings".** This includes Route 108:Treasure Island, Route 76:Marin Headlands, and La Honda Youth Detention Center Shuttle to San Mateo County. These routes are not in the service area and may not be included within the scope of the Project. The routes may be considered separately by the SFMTA in the future.

Coverage of the entire southern route in San Mateo County using the SFMTA's tower sites is not required. However, service access could be accomplished through the use of the Project 25 ISSI (Inter-RF Sub-System Interface). The County of San Mateo is planning to construct a Project 25, 700 MHz network which may provide coverage to large portions of this southern route, and it is anticipated that San Mateo County will implement ISSI. The SFMTA's future implementation of ISSI shall be interfaced with the County of San Mateo's to provide this coverage. This would allow the SFMTA users on this route to switch to the San Mateo County network when necessary and the ISSI would convey the voice message back to the SFMTA network.

The Contractor shall provide the following coverage analyses **[CDRL 12-2-7 Coverage Analyses]:**

- Portable talk-in for each site
- Portable talk-out for each site
- Portable talk-in Composite
- Portable talk-out Composite
- Mobile data talk-in for each site
- Mobile data talk-out for each site
- Mobile data talk-in Composite
- Mobile data talk-out Composite
- Portable talk-in Tunnel(s)
- Portable talk-out Tunnel(s).

2.3.7 Link Budget Analysis

As part of the Qualified Proposer's Proposal and Contractor's design submittal a detailed link budget analysis of above ground and underground shall be provided for the proposed radio system showing the following assumptions to establish measured talk-in, talk-out portable radio signal levels corresponding to the criteria specified in the "Radio Propagation Requirements" section **[PRL 12-2-7 Link Budget Analysis]**:

- Guaranteed static sensitivity for mobile and portable radios (dBm), and corresponding SINAD (analog) and/or BER (digital) performance
- Faded sensitivity for mobile and portable radios (for DAQ 3.4) in dBm, and corresponding SINAD (analog) and/or BER (digital) performance
- Statistical distribution assumed for multipath fading (Rayleigh, Nakagami-Rice, etc.).
- Statistical assumptions used to account for location variability (i.e. adjustment from a median reliability value of 50% in a given coverage sector or grid segment to provide reliable operation at 95% of the locations in that sector or grid segment).
- Transmit antenna system gain (dBd)
- Transmission antenna system loss (dB)
- Base Station Receiver Multi-coupler Net Gain (dB)
- Base Station Receiver Multi-coupler Noise Figure (dB)
- Mobile radio antenna system net gain (dB)
- Mobile radio transmitter output power (dBm).
- Portable radio antenna system net gain (or loss), including body losses for at the hip level operation, as described above (dB)
- Portable radio transmitter output power (dBm)
- Assumptions regarding talk-out and talk-in path reciprocity (e.g. any offset factor used to compensate for the difference between talk-out and talk-in coverage and to allow talk-out signal targets and acceptance test procedures to be used to confirm talk-in coverage reliability.
- Assumptions regarding any difference between talk-out and talk-in transmission paths and system performance that may affect the validity of the assumption of path reciprocity with an offset for the difference in base station and mobile and/or portable radio transmitter output power, as described in TIA TSB-88, Section 5.7.3.4, Talk-Out vs. Talk-In Testing.

- RF propagation prediction model (including version number, if applicable) used to provide coverage predictions. The method of verification of the above coverage criteria is described in “Radio Propagation Requirements” section.
- All of the Qualified Proposer’s shall submit talk-in coverage maps for the proposed system shall be based on the calculated link budgets which indicate this is the limiting link in the Qualified Proposer’s design. If this is not true then both talk-in and talk-out coverage maps are required for each coverage type. All coverage maps shall be based on the assumptions shown in the link budget analysis described above.

The Contractor shall provide a complete link budget analysis with the above specified information for the entire system including **[CDRL 12-2-8: Link Budget Analysis]**:

- Underground, portable to donor antenna
- Above ground, base station to portable.

2.4 System Requirements

The radio communication system shall be designed to meet the needs of both the PSVRN and MTMS. The PSVRN is an interoperable Phase II, Project-25 compliant voice radio system for joint use by the selected SFMTA staff and City and County of San Francisco public works employees (Department of Public Works, Port of San Francisco, and Department of Building Inspection). The MTMS shall include but not be limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information. It is understood that the MTMS may operate independently of the PSVRN but, that they are fully interoperable with each other.

Transit operations includes all Muni fleet modes, including light rail vehicles, cable cars, historic rail vehicles, electric trolley buses, motor coaches, and selected non-revenue vehicles. The new radio systems will also provide radio services to Muni operations and maintenance personnel who use handheld mobile radio and/or handheld mobile data devices.

The radio system implementation will achieve the following goals:

- Turn-key implementation of the design and construction of the system
- Designed for no single fault failures that would create a catastrophic system failure
- Redundancy of major sub-components
- Optimally efficient frequency utilization
- High hardware and software availability, reliability and survivability
- Easily maintainable, upgradeable, expandable systems
- Improved overall coverage with no geographic restrictions between and among mobile and handheld radio units than the current system
- Up-to-date technology with digital infrastructure
- Open architecture interface(s) to neighboring systems
- Communications backbone compatibility of a wireless Intelligent Transportation Systems (ITS) consistent with the San Francisco Bay Area's ITS Regional Architecture
- Increased capacity to support voice and data transmission requirements
- Improved operational efficiency and flexibility in communications systems
- Flexibility and simplicity in creating and maintaining multiple talkgroups
- Integration into the regional P25 voice and data core network, if applicable
- Communications interoperability with the City and County of San Francisco Department of Emergency Management’s radio systems and other regional public safety services
- Capability to interface with the other SFMTA information technology systems
- Fully integrated radio communications within the existing and planned SFMTA infrastructure

- Record talkgroups and dispatch radio and telephone conversations
- Capability to rapidly transition to a future backup Operations Control Center

The radio system shall provide all equipment, software, and services for the turn-key operation of the voice and data communications for the PSVRN and MTMS users operating in the SFMTA's service area.

The Contractor shall be responsible for the integration and operation of all equipment and subsystems provided by the Contractor, regardless of manufacturer.

The Contractor shall provide a complete set of LMR system drawings, including but not limited to **[CDRL 12-2-9: LMR System Drawings]:**

A. System drawing

B. Site drawings per radio site:

1. Site location
2. Floor plan
3. Equipment Rack-up
4. Tower drawings
5. Designed electrical (primary and secondary power)
6. Designed grounding
7. Site modification drawings
8. Tower drawing with antenna placements

C. Prime Site drawing

1. Floor Plan
2. Equipment rack-up drawing

D. Network drawing

E. Dispatch Drawing

1. Console control and associated equipment rack-up
2. Console control and associated equipment floor plan
3. Console floor plan

F. Antenna System

1. Antenna system per site
2. Antenna support for each tower
3. Grounding

2.4.1 Interoperability

To support the region's future interoperability goals, the PSVRN shall support all P25 interoperability standards and capabilities consistent with TIA 102 standards.

The PSVRN shall be capable of providing the SFMTA and CCSF subscribers interoperability to city, local, county, state and Federal agencies. The Qualified Proposer shall discuss how interoperability shall be provided in this system **[PRL 12-2-6 Interoperability Design]**.

The Contractor shall include an open architecture system to system interface as defined in the P25 Inter RF Subsystem Interface (ISSI).

The PSVRN shall be capable of interoperability with the CERS. The CERS is in the process of upgrading to a P25 system.

The PSVRN shall be interoperable with the Interoperable Radio System. This four (4) site simulcast system provides emergency communications for CCSF.

The PSVRN shall interface with the SF 911 Dispatch Center. The specific design approach for this interface shall be defined during the Intermediate Design Review.

MOU's may be developed in the future for system to system links to Marin County, San Mateo County and Golden Gate Highway and Transportation District.

2.4.2 Network Management System Operational Functions

The Network Management System (NMS) shall provide a graphical user interface and extensive on-line help database. Subscribers shall be interfaced to the trunked/conventional mobile radio system through a standard IP interface protocol.

The system shall have capacity for over 40,000 individual radio IDs and over 2,000 talkgroups. Additionally, the system shall support additional radio ID's that may roam into the SFMTA radio system and operate using the ISSI P25 standard.

The Contractor shall anticipate configuring the new radio subsystem with the talkgroups specified in **Appendix Twenty-One (21), "SFMTA's Planned Talkgroup List"**. The Contractor shall work with CCSF and the SFMTA to create talkgroups and fleet maps as needed. The Contractor shall perform two (2) subscriber programming cycles:

- Initial deployment programming of template (e.g. Talkgroups or any other subscriber parameter}
- Reprogramming of subscribers to improve fleet map efficiency and programming error as requested by the SFMTA.

The Talkgroups shall be established as a Final Design Review (FDR) completion item.

The Contractor shall be responsible for the correct programming of all system and subscriber equipment. The Contractor shall reprogram all equipment that is incorrectly programmed at no expense the SFMTA.

NMS access shall be provided within the Operations Control Center for system performance monitoring and maintenance purposes. The network management system shall be accessed through a System Manager Terminal (SMT).

System calls shall be processed using least 10 levels of user priorities in the calling process. Priority to calls, to or from particular voice groups or to particular types of calls, with the highest level of priority assigned to emergency shall be provided.

The system shall assign available voice channels and shall queue calls based on call priority levels. Priority levels shall be programmable via the SMT.

2.4.3 700/800 MHz Trunked and Conventional Operation

The radio system shall be configured as a single trunked network with regard to its architecture for providing wide-area coverage. The radio system and user equipment shall provide fully automatic site registration, channel selection, talkgroup and individual call routing as required between sites within the network and without user intervention as the user "roams" between sites. This shall apply to both voice and data.

2.4.4 Modulation Types and Technology

Base stations, control stations, mobile radios, and portable radios used in the system shall comply with all applicable requirements of Part 90, and in particular Subpart S, Regulations Governing the Licensing and Use of Frequencies in the 806-824, 851-869, 896-901, and 935-940 MHz Bands, and Subpart R, Regulations Governing the Licensing and Use of Frequencies in the 763-775 and 793-805 MHz Bands. This includes, but is not limited to, the following specific requirements:

- Phase II, TDMA modulation
- Mobile, portable, and control station radios used on the mobile radio system shall be capable of digital or analog conventional and trunked operation in the 700/800 MHz band or 700 MHz band. The SFMTA shall utilize analog for basic interoperable communications.
- Mobile transmitters and receivers shall operate in voice and data modes to support the SFMTA's voice and data requirements.

2.4.5 Voice Calling Functions

The trunked voice portion of the SFMTA radio system shall provide the following types of system calls:

- **Group Call** a call from a Radio Dispatcher to a group of mobile and portable radio users who are members of a single voice group, or a call from one member of such a voice group to all other members of the same voice group.
- **Private Call** a call from a Dispatcher to a single radio user (e.g. to a bus operator in response to a RTT or PRTT), or from one single user (with a unique radio ID) to another single user (with a unique radio ID) on the system.
- **Fleet Call** a call, usually from a Radio Dispatcher, to all members of several voice groups, up to and including all radios on the system.
- **Ad hoc Calls** to Dispatcher selected subscribers through the selective calling features supported by the MTMS.

2.4.6 System Functional Features

The Contractor shall implement a system that provides, at a minimum, the following features:

- Individual radio enable/disable
- Pre-canned or custom text messaging
- Current unit voice group affiliation (unit search)
- Activity (PTT-ID) Display
- NMS password/access levels
- Trunked and conventional channel conditions (activated/idle/failed)
- Enable/disable selected trunks/channels
- Priority levels (unit and voice groups)
- Unit, voice group and trunk usage reports
- Complete integration with the MTMS.

2.6 Desktop Control Stations

2.6.1 Control Station General Requirements

Control stations and desk sets specifications are listed below:

- Rated for 10% transmit, 10% receive, and 80% standby.
- Equipped with:
  - a handset with PTT switch
  - integral speaker
  - microphone
  - volume control
  - provisions for adding a desktop microphone.
- Operate from 120 VAC unless otherwise noted.
- Fully operational and maintain all settings previously in effect following restoration of power
- Capable of operating in trunked mode on the wide-area system
- Available in a rack-mount configuration, designed to minimize occupied space for multiple control stations in a single cabinet.

The control stations shall be connected to a facility UPS if available.

Control stations shall be installed at locations defined in **Appendix Fourteen (14), "Required SFMTA User Work Stations & Licenses".**

Qualified Proposers shall provide a complete description of the proposed desktop control station equipment **[PRL 12-2-7 Desktop Control Station Equipment Description]**.

The Contractor shall provide complete description of the mobile equipment provided **[CDRL 12-2-10 Desktop Control Station Equipment Description]**.

2.6.2 Control Station Technical Features

The desktop control stations shall meet the following technical specifications:

- Capable of operation on narrowband (12.5 kHz), mid-bandwidth (NPSPAC) and wideband (25 kHz) channels. No software or firmware changes shall be required to change between bandwidths.
- Programmable to encode and decode any combination of 37 EIA CTCSS and 83 standard DCS codes.
- Coded squelch encode and decode tones shall be channel-slaved, and the radio shall be capable of operating with encode tones that are different from the receiver decode tone. A monitor switch shall be provided to enable or disable the coded squelch function for maintenance.
- Capable to reprogram the radio template in the field using a portable computer. The connection shall be accessible without requiring the removal of equipment from its mounting bracket or from the equipment rack.
- Housed in rugged cases with the following features:
  - Utilize gaskets to seal against dust infiltration at all points of access
  - No internal ventilation shall be required
  - Cable connectors shall be securely attached to unit.
- Metering of all essential circuits shall be possible while the radio is installed and operating, and may be accomplished through software control
- A time-out timer shall turn off the transmitter after a time interval (adjustable up to three (3) minutes) of continuous transmit, generate an alert tone on the radio speaker, and reset upon release of the PTT switch. It shall be possible to completely disable the timeout timer. This timer shall not be activated if the security (covert monitoring) microphone becomes operational in a revenue vehicle.
- Capable of "cloning" a radio template (without individual ID numbers) to minimize future reprogramming costs.
- Capable of individual identification numbers that are transmitted with every PTT.
- Equipped with an 8-character alphanumeric display to allow the user to assign a descriptive name to each operating condition.
- Displays shall be clearly labeled and visible in a brightly lit equipment room, with variable brightness.
- The display shall either be backlit or vacuum florescent for visibility in a darkened room.

- Capable of a minimum 128-channel operation with user selectable Talkgroup scanning capability
- Arranged to operate in the control station mode using the same transmit and receive frequencies as the mobile units, to provide access to the base stations, in the event of a failure of the communications links to the base station sites
- The interface between each control station and the SFMTA radio dispatcher workstation shall be provided by Contractor.
- For remote control, each workstation shall have the controls for its associated control station integrated into the Dispatch workstation via the centralized electronics equipment and shall operate in the same manner as any station.

2.6.3 Control Station Technical Parameters

Control Station Transmitter	
Parameter	**Required Performance**
Frequency Range	**763-869 MHz**
Maximum Frequency Separation, no degradation	**Full BandSplit**
Programmable Channel Steps	**12.5 kHz**
Minimum Power Output (EIA Intermittent)	**15 W**
Emission Designators	**11K3F3E**
Spurious and Harmonic Emissions	**-60 dB**

Control Station Receiver	
Parameter	**Required Performance**
Frequency Range	**764-776 MHz or 851-869 MHz**
Maximum Frequency Separation, no degradation	**Full BandSplit**
Channel Spacing	**12.5 kHz**
Sensitivity, 12 dB SINAD/Static BER (5%)	**0.30 µV**
Selectivity, EIA: 12.5 kHz	**-65 dB**
Intermodulation Rejection	**-65 dB**
Spurious and Image Rejection	**-70 dB**
Speaker Input Power (minimum)	**3 W**

2.7 Portable Equipment

The Contractor shall furnish portable radios operating on any of the primary frequencies in the 763-869 MHz land mobile bands.

It is the intent of this section to describe state-of-the-art portable radio equipment. The equipment shall be comprised of a handheld transceiver, associated accessories, antenna and user functions and controls. The equipment shall be operated in a FDMA and TDMA mode.

The units shall be of current production and shall be capable of withstanding the harsh environment associated with use by public safety and public service personnel.

The units shall be feature and function compatible with the fixed and mobile equipment supplied under this contract.

Portable radios shall be made available in multiple tiers, each of which offers varied feature packages from basic level to advanced functionality. With each of the SFMTA-specified level set forth below, the Contractor shall indicate a single unit/model that best meets each tier's overall requirements. In addition, the Contractor may divide any of the SFMTA-specified tiers, below, into additional tiers and propose subscriber equipment for those tiers. The minimum requirements for each tier are further described below.

Qualified Proposers shall provide a complete description of the proposed portable equipment **[PRL 12-2-9 Portable Equipment Description]**.

The Contractor shall provide complete description of the portable equipment **[CDRL 12-2-11 Portable Equipment Description]**.

2.7.1 Quantities

The SFMTA quantities and types per quantity for portable equipment are listed in **Appendix Twenty- Eight (28), "Cost Proposal".**

2.7.2 Regulatory Compliance

All subscriber equipment provided shall be type accepted under Part 90 of the FCC Rules & Regulations. Narrowband operations shall comply with 47 CFR 90.547 & 47 CFR 90.548 of the FCC Rules and Regulations.

All portable radios shall be of heavy duty construction, suitable for continuous public safety use.

Portable radios and all their associated accessories shall be capable of withstanding shock, vibration, temperature, humidity, dust, and driven rain, per MIL-STD 810-E.

2.7.3 General Electrical & Mechanical Requirements

The Contractor shall provide portable radio equipment that meets the following specifications:

- State-of-the-art and microprocessor based
- All operating parameters shall be stored in electrically alterable non-volatile memory technology
- Operating frequencies, features, functions and other operating parameters shall be field-modifiable via PC based programmers
- The physical and electrical architecture of the equipment shall be such that addition of user features and/or functions at future dates shall not require addition and/or replacement of circuit cards within the unit
- All equipment assemblies and sub-assemblies shall be shielded to minimize electromagnetic interference which may be caused to/by electrical equipment in close proximity to this equipment
- Self-diagnostic test each time it is turned on. This test shall be automatic and shall include all radio operating parameters. At the conclusion of a successful test, no operator intervention shall be required to activate on the network. A test that is not successful shall notify the operator
- Rated by Factory Mutual or other accrediting organization as intrinsically safe.

2.7.4 Portable Technical Specifications

The minimum required technical specifications for portable radio transmitters measured in accordance with TIA -603, TIA-102.CAAA-B and TIA-102.CAAB-B procedures are as follows:

Portable Radio Transmitter Specifications	
Frequency Range	763-869 MHz
Programmable Channel Steps	12.5 kHz
Power Output	2.5 W minimum
Frequency Stability	±1.5 PPM, -20°C to +60° C
Duty Cycle Rating	5% Tx, 5% Rx, 90% standby
RF Output Impedance	50 Ohms
Emission Designator	Per FCC 90.207
Modulation Limiting	±2.5kHz
Spurious and Harmonic Emissions	-48 dBc
FM Hum and Noise	-45 dB
Audio Distortion	Maximum 5% @ 1000 Hz

Portable Radio Receiver Specifications	
Frequency Range	764-776 MHz or 851 to 869 MHz
Channel Bandwidth	12.5 kHz
Input Impedance	50 Ohms
Frequency Stability	±1.5 PPM%, -20°C to +60° C
Sensitivity, 12 dB SINAD/Static BER (5%)	0.35 uV @ 12.5 kHz
Adjacent Channel Rejection	-63 dB
Intermodulation Rejection	-62 dB
Spurious and Image Rejection	-65 dB
Audio Output Power @ 8 ohm	500 mW minimum
Audio Distortion	Maximum 5% @ rated output

2.7.5 Tier 1 Radio Type

Tier I portable radio features shall include:

- Volume control
- Talk group/channel selector (minimum of 16)
- Emergency button
- Push-to-talk
- Remote microphone/speaker connector
- Ability to monitor channel/talk group with transmit feature inhibited
- Ruggedized option for severe service conditions such as marine use
- Ability to receive individual calls
- Ability to receive private unit-to-unit calls
- Audible low battery indicator.

2.7.6 Tier 2 Radio Type

Tier II portable radio features shall include the Tier 1 radio features plus, at a minimum, the following::

- Display
- Industry-standard data interface
- As many as four programmable keys
- Encryption capability.

2.7.7 Tier 3 Radio Type

Tier 3 portable radio features shall include the Tier 2 radio features plus, at a minimum, the following::

- Remote antenna connector
- Alphanumeric keypad that support DTMF and individual unit calling. The keypad shall be a typical 12-button configuration to achieve the full DTMF capability
- Ability to send and receive individual calls
- Ability to send and receive private unit-to-unit calls
- Call-book memories (phone numbers, etc).

2.7.8 Visual Display

Tier III portable subscriber units shall have the following visual display features:

- Back-lit display visible in bright sunlight
- Readable in direct sunlight
- Readable in darkness
- Display brightness (for nighttime use) as an operator-adjustable feature
- Ability to fully dim display.

2.7.9 Keyboard

Tier III portable subscriber units shall have the following keypad features:

- Made of a non-slip material
- Provide tactile feedback
- Arranged so as to prevent accidental operation
- Clearly labeled
- Clearly visible
- Keypad shall be back-lit labels for nighttime use
- Ability to emit an audible signal each time a key is pressed.

2.7.10 Power Supply

Power supply equipment shall operate from a negative ground internal battery power source. All power circuits shall provide for reverse polarity protection.

2.7.11 Equipment Housing

The transceiver housing shall house all electronic circuits and/or circuit cards associated with the equipment.

The housing shall be constructed of high impact polycarbonate plastic or other suitable high impact material.

Removal of the battery from the unit shall not expose its internal circuitry.

2.7.12 Device Interface

Device interfaces shall accommodate data input devices that use RS-232 or USB connectivity.

To provide the highest degree of functionality, Tier III portable and mobile subscriber units shall have the capability to interface with independent peripheral devices through use of the standard interfaces available on the radios. Examples of peripheral devices are:

- Mobile computer terminals
- Printers
- Facsimile machines
- Image scanners
- Finger print scanner
- Bar code reader
- Card reading device
- Digital camera.

2.7.13 Operating Bandwidth

Portable units shall operate over the entire 700/800 MHz radio channel allocation without degradation.

2.7.14 Modulation Modes

Modulation mode shall be Phase II, P25 TDMA. The radios shall also be capable of narrowband – 12.5 kHz capable and wideband 25 KHz capable.

2.7.15 Operating Modes

Portable equipment shall support the following operating modes:

- Trunked and conventional.
- Half Duplex and Simplex
- Operating modes shall be field programmable on a voice group and per channel basis.

2.7.16 Communications Modes

Portable equipment shall operate in both clear audio mode and in encrypted audio mode (option).

2.7.17 Audio Output

The audio output power of a Tier III portable subscriber unit shall be at least 500-milliwatts.

2.7.18 Handheld Microphones

Portable subscriber units shall have, as an option, the following handheld microphone features:

- Programmable function keys
- DTMF keypad
- Noise canceling
- Lapel clip.

2.7.19 Portable Antennas

Portable subscriber units shall be equipped with a detachable unity-gain antenna.

The antenna shall be field replaceable, without tools.

Where appropriate, the attached speaker-microphone, or attached handheld microphone, shall incorporate the antenna.

2.7.20 Knobs

If applicable, portable subscriber units shall have the following knob features:

- Made of a non-slip material
- A design, such as a detented surface, to provide tactile feedback.
- Arranged so as to prevent accidental operation
- Clearly labeled
- Clearly visible.

2.7.21 Battery

Battery operation time shall be no less than 8 hours at 5% transmit, 5% receive, and 90% standby or a 5-5-90 duty cycle.

Extended battery operation time, beyond the minimum 8 hours, should be accomplished through such techniques as transmitter power management, if offered by the Contractor.

The battery shall be of a type that does not exhibit a “memory” effect for the predicted life of the battery.

The battery shall be of a type that can accept a fast charge rate of 1 hour from fully discharged to fully charged.

2.7.22 Battery Charger

The Contractor shall provide battery chargers for portable subscriber units with the following features:

- Drop-in charger
- Capable of charging portable subscriber batteries to full capacity within 60 minutes
- Auto shut-off feature that stops charging the battery when it has reached full charge and maintains a battery float condition
- Available with a capability to condition the battery during the battery recharging cycle
- Available with an integrated capacity-testing feature
- Available in single and multi-unit chargers
- Available in single unit chargers with a 12 volt DC input power to be installed in vehicles to power spare batteries.

The Contractor shall install one (1) battery charger in each non-revenue vehicle and two (2) in each train.

2.8 Mobile Equipment

It is the intent of this section to describe state-of-the-art 700/800 MHz trunked mobile radio equipment for the replacement of the existing mobile radio fleet. The equipment shall be comprised of a transceiver, associated accessories, antenna and user functions and controls. The equipment shall be operate in a FDMA and TDMA mode.

Mobile radios shall interface and integrate into the vehicle and a vehicle control head is required in order to meet overall functional requirements for an integrated radio design capable of supporting voice and data communications within one radio. Functionality for volume control of handset, speaker and routing of local audio to the vehicle public address system shall also be provided for vehicles.

The Contractor shall be responsible for the protocol and hardware interface between the radio and the vehicle logic unit (VLU) on any vehicle.

All mobile radios shall be of rugged construction, suitable for continuous public safety use. Mobile radios shall be capable of withstanding shock, vibration, temperature, humidity, dust, and driven rain associated with mounting in vehicles per MIL-STD 810-E.

The units shall be of current production and shall be capable of withstanding the harsh environment associated with use in public safety and public transit vehicles

Mobile radios shall be made available in multiple tiers that offer varied feature packages from basic level to advanced functionality.

The Contractor shall offer special mobile radio configurations for motorcycle, marine, and aircraft operations. The Contractor shall offer mobile radio designs for low-profile, covert operations vehicles.

With each of the SFMTA-specified level set forth below, the Contractor shall offer a single unit that best meets each tier's overall requirements. In addition, the Contractor may divide any SFMTA-specified tier, below, into additional tiers and propose subscriber equipment for those tiers. The minimum requirements for each tier are further described below. .

The mobile radios shall be feature and function compatible with the fixed equipment to be provided by the Contractor.

Qualified Proposers shall provide a complete description of the proposed mobile equipment **[PRL 12-2-8 Mobile Equipment Description]**.

The Contractor shall provide complete description of the mobile equipment provided **[CDRL 12-2-11 Mobile Equipment Description]**.

2.8.1 Quantities

The SFMTA quantity requirements are listed in **Appendix Thirteen (13), "SFMTA Vehicle Inventory".**

2.8.2 Regulatory Compliance

All mobile equipment offered shall be type accepted under Part 90 of the FCC Rules & Regulations. Narrowband operations shall comply with 47 CFR 90.547 & 47 CFR 90.548 of the FCC Rules and Regulations.

Meet or exceed all the requirements of MIL-STD 810E standards for shock, vibration, salt, fog, dust and rain.

2.8.3 General Electrical & Mechanical Specifications

The Contractor shall provide mobile radio equipment that meet the following specifications:

- State-of-the-art and microprocessor based.
- All operating parameters shall be stored in electrically alterable non-volatile memory technology.
- Operating frequencies, features, functions and other operating parameters shall be field-modifiable via PC based programmers.
- The physical and electrical architecture of the equipment shall be such that addition of user features and/or functions at future dates shall not require addition and/or replacement of circuit cards within the unit.
- All equipment assemblies and sub-assemblies shall be shielded to minimize electromagnetic interference which may be caused to/by electrical equipment in close proximity to this equipment..
- Self-diagnostic test each time it is turned on. This test shall be automatic and shall include all radio operating parameters. At the conclusion of a successful test, no operator intervention shall be required to activate on the network. A test that is not successful shall notify the operator.

2.8.4 Mobile Radio Technical Features

The mobile radios shall have the following features:

- 100% solid-state, frequency-synthesized FM unit designed for reliable, long-term usage under adverse public safety public service conditions.
- Meet all specifications, including oscillator stability, within 3.5 seconds of power-on
- Capable of trunked and conventional repeater operation or talk-around on any of the primary frequencies in the 700/800 MHz land mobile band.
- Receiver selectivity and transmitter voice frequency response, deviation, and transmit power shall be automatically controlled by an internal microprocessor, based on transmit and receive frequency selection. It shall not be necessary to program these parameters for each radio frequency.
- A port on the radio to be used for programming shall be accessible without requiring the removal of equipment from the mounting brackets.
- Protected against damage in the event of DC power lead reversal or over-voltage.
- Internal batteries shall not be required to maintain the radio personality.
- Capable of transmitting an emergency alarm from the vehicle to the Dispatcher Console in fall-back mode
- The radio personality shall be capable of being reprogrammed in the field, using a laptop computer.
- Operating bandwidth shall include the entire 700/800 MHz radio channel allocation without degradation, minimum.
- Mobile radios shall be capable of Narrowband – 12.5 kHz capable modulation.
- Operating modes shall be field programmable on a voice group and per channel basis for trunked and conventional operations in either half duplex or simplex.
- Mobile equipment shall operate in both clear audio mode and in encrypted audio mode (option).

Qualified Proposers shall describe their experience with the interfacing the vehicle logic unit (VLU) and a mobile radio without a control head, including any radio protocol and hardware interfaces **[PRL 12-2-9 Vehicle Logic Unit Interface to Mobile Radio Description]**.

2.8.5 Technical Specifications for Mobile Radios

The minimum required technical specifications for mobile radio transmitters measured in accordance with TIA -603, TIA-102.CAAA-B and TIA-102.CAAB-B procedures are as follows:

Mobile Radio Transmitter Specifications	
Frequency Range	**763-869 MHz**
Programmable Channel Steps	**12.5 kHz**
Power Output	**30 W minimum**
Frequency Stability	**±0.00015%, -20°C to +60° C**
Duty Cycle Rating	**Intermittent (20% Tx)**
RF Output Impedance	**50 Ohms**
Emission Designator	**Per FCC 90.207**
Modulation Limiting	**±2.5kHz**
Spurious and Harmonic Emissions	**-60 dBc**
Audio Distortion	**Maximum 3% @ 1000 Hz**
FM Hum and Noise	**-40 dB**
Audio Response	**Within +1, -3 dB of 6 dB per octave pre-emphasis from 300 to 3000 Hz, referred to 1000 Hz**

The minimum required technical specifications for mobile radio receivers measured in accordance with TIA-603, TIA-102.CAAA-B and TIA-102.CAAB-B procedures are as follows:

Mobile Radio Receiver Specifications	
Frequency Range	**764-776 MHz or 851 to 869 MHz**
Channel Spacing	**12.5 kHz**
Input Impedance	**50 Ohms**
Frequency Stability	**±0.00015%, -20°C to +60° C**
Sensitivity, 12 dB SINAD/Static BER (5%)	**0.30 uV @ 12.5 kHz**
Adjacent Channel Rejection	**-65 dB**
Intermodulation Rejection	**-80 dB**
Spurious and Image Rejection	**-80 dB**
Audio Output Power (minimum)	**3 watts internal / 5 watt external speaker**
Audio Distortion	**Maximum 3% at rated output**
Audio Response	**Within +1, -3 dB of 6 dB per octave de-emphasis from 300 to 3000 Hz, referred to 1000 Hz.**

2.8.6 Control Heads

The Contractor shall install remote control heads for all non-revenue vehicles. Refer to the vehicle drawings for the placement of the control heads in the various vehicles.

Mobile radios attached to VLU's shall not have control heads.

2.8.7 Mobile Radio – Tier 1

Tier 1 mobile radio features shall include:

- Volume control
- Talk group/channel selector (minimum of 16)
- Emergency button
- Push-to-talk
- Speaker
- Auxiliary microphone/speaker connector
- Ability to monitor a channel/talk group with transmit feature inhibited
- A peripheral unit or outboard status panel necessary for signaling status shall be available for mobile subscriber units that do not include this feature
- Ability to receive individual calls
- Ability to receive private calls.

2.8.8 Mobile Radios – Tier 2

Tier 2 mobile radio features shall include:

- Tier 1 mobile radio features
- Display
- Global Positioning System (GPS) capability
- Encryption option.

2.8.9 Mobile Radios – Tier 3

Tier 3 mobile radio features shall include:

- Tier 2 mobile radio features
- Alphanumeric keypad that supports DTMF and individual unit calling. The keypad shall be a typical 12-button configuration to achieve full DTMF capability
- Ability to send and receive individual calls
- Ability to send and receive private unit-to-unit calls
- Nonvolatile user programmable memories (phone numbers, etc.).

2.8.10 Mobile Radios – Tier 4

Tier 4 radios shall have the features of a Tier 1 radio. The Tier 4 radio shall be capable of operating with the Vehicle Logic Unit (VLU) without a control head. The VLU shall function as the control head for the radio. The Contractor shall provide an Application Protocol Interface to the VLU vendor to develop programs to control the radio.

2.8.11 Visual Display

Tier 2 and 3 mobile subscriber units shall have the following visual-display features:

- Back-lit display, which shall be visible in bright sunlight
- Readable in direct sunlight
- Readable in darkness
- Display brightness (for nighttime use) as an operator-adjustable feature
- Ability to fully dim display for covert nighttime operations.

2.8.12 Keyboards

Tier 3 mobile subscriber units shall have the following keypad features:

- Made of a non-slip material
- Provide tactile feedback
- Clearly labeled
- Clearly visible
- Back-lit labels for nighttime use
- Ability to emit an audible signal each time a key is pressed.

2.8.13 Standard Speakers

Mobile subscriber units shall have the following audio power output features:

- 5-watt peak audio power output standard
- 10-watt peak audio power output optional.

2.8.14 Auxiliary Speakers

The mobile subscriber units shall have the following auxiliary speaker features:

- Amplified to produce 25-watt peak audio power output
- Provided with a mating connector set.
- Option for an external, weatherproof speaker.

2.8.15 Handheld Microphones

A handheld microphone shall be included with all mobile radios, with a connector to permit ease of removal and replacement. Tier 4 radios shall use the VLU handset.

The mobile units shall be capable of interfacing to a variety of microphone options suited to the radio use and user. The microphone cord shall be long enough to be used comfortably when seated in the operator's seat of the vehicle, but with minimum surplus slack. The microphone cord shall be coiled.

2.8.16 Power Requirements

All subscriber units shall operate from an external negative ground primary power source supplying a nominal 12 VDC. All power circuits shall provide for reverse polarity protection. The radio shall meet specifications when operating between 11 VDC and 15 VDC, negative ground.

The subscriber units to be installed in the Light Rail Vehicles (LRV) shall operate on 37VDC. As such, the Contractor shall have to incorporate a power converter for these vehicles.

The Qualified Proposer shall design power filter on all of the LRV's.

The Contractor shall design the mobile radio installation to minimize any transient electrical surges. Special light rail vehicle requirements are specified in **Appendix Twenty-Two (22).**

A power converter shall be made available for any other type of power source that may be encountered on vehicles trains, or cable cars.

A power filter shall be installed on the power circuit to the radio.

The Contractor shall provide a delay timer in line with the power circuit to the radio. The delay timer shall allow the radio and mobile data terminal (MDT) to be shut down after a preset time interval of at least 15 minutes. The delay timer shall have an under voltage sensor to allow for the shutdown of the radio and MDT.

The Contractor shall install new power and ground cables for each radio. Unless approved by the SFMTA, the Contractor shall not reuse any existing radio power lines.

2.8.17 Vehicle Antennas

The Contractor shall install fixed mount antennas for a variety of installation types, including vehicles, trains and cable cars.

All rubber-wheeled revenue vehicles shall utilize transit-style 700/800MHz antenna (i.e. blade).

All non-revenue vehicles shall use a 700/800MHz low-profile antenna (i.e. hockey puck or cylinder type).

Optionally, the Contractor shall provide a combined tri-band (700/800/GPS) antenna for all the SFMTA vehicles Optionally, a combined GPS and 800 MHz antenna shall be provided for for vehicles that require such an antenna

Optionally, a magnetic-mount antenna shall be provided for applications that require such an antenna.

Optionally, a non-ground plane type antenna shall be made available for applications that require such an antenna, such as some vessels.

Optionally, low-profile, covert antennas shall be made available for applications that require such an antenna, such as cable cars

The Contractor shall install new transmission lines for each antenna. Unless approved by the SFMTA, the Contractor shall not reuse any existing radio transmission lines.

2.8.18 Knobs

If applicable, mobile subscriber units shall have the following knob features:

- Made of a non-slip material
- A design, such as a detented surface, to provide tactile feedback.

2.8.19 Equipment Housing and Physical Requirements

The radio housing shall house all electronic circuits and/or circuit cards associated with the equipment. Palm microphones, external speaker housings and radio housings shall be constructed of high impact polycarbonate plastic or other suitable high impact material. Remote mounted transceiver housings shall be equipped with a base plate. The base plate shall allow for the removal of the transceiver from its mounted location for replacement or servicing. Removal of the radio from the base plate shall not expose its internal circuitry.

Mobile radios shall meet the following physical operating requirements (light rail vehicle specific requirements are found in **Appendix Twenty-two (22)**):

- Meet specifications under ambient conditions of -20° to +60° C, and 5% to 90% relative humidity.
- Cable connectors shall be securely attached to the mobile via hermetically sealed connectors.
- Fuses or circuit breakers installed in vehicles shall be easy to reach, labeled "Radio", and have the proper replacement fuse amperage identified.
- One spare fuse for each mobile installation shall be provided.
- The radio shall not receive or transmit ignition noise, alternator whine, or other forms of interference. The Contractor shall be responsible to equip radios with noise-reducing hardware and/or redesign installation wiring to eliminate interference problems.
- Details of mounting and installation will vary among vehicle types and shall be coordinated with the SFMTA or their designated representative.

2.8.20 Mobile Radio Operational Features

Mobile radio operational features shall include:

- Non-revenue vehicles provided with a user interface (control panel or control head) containing volume control, voice group and conventional channel select.
- Mobile equipment shall support the following identification modes:
  - Unit ID on Push-To-Talk
  - Emergency Unit ID, operator activated via microphone Push-To-Talk.
- Revenue vehicles provided with no user interface (control panel or control head) containing volume control, voice group and conventional channel select
- An alphanumeric character display to identify the trunked voice group, conventional channel and other users prompts required to operate or diagnose the unit shall be provided.
- The display shall not display less than eleven (11) characters and its brightness shall be user adjustable.
- Provided with a user configurable trunked voice group/conventional channel scan feature.
- The scanner shall allow the user to selectively add or omit talk groups or channels from the scanning sequence.
- A mix of talk groups and channels shall be allowed in the scanning sequence. User selectable talk group/channel priority shall be provided.
- All mobile units shall be equipped with an external P25 data port.
- Test equipment, radio-programming devices, etc. shall be capable of connecting to the mobile radio via an additional data port.
- Remote control of mobile radio functions via the microphone
- Signal strength indicator on mobiles.

2.8.21 Device Interface

Device interfaces shall accommodate data input devices that use RS-232 or Universal Serial Bus (USB) connectivity.

2.9 Radio System Fixed Equipment Requirements

This section describes the minimum quality and specification requirements of the radio system fixed equipment and software. All equipment shall be commercially available, service proven, and not in an alpha or beta release state.

2.9.1 General Requirements

The Contractor shall provide new, high-quality, modern, equipment that is designed, manufactured, and installed for public transit service and public safety users. The equipment shall be designed to provide a long life, high reliability, rugged performance under adverse conditions, and low maintenance.

General system requirements include:

- Implementation of the system shall meet the highest current standards for operation in public-transit service.
- Equipment and material furnished shall meet or exceed all the requirements of this RFP and of the manufacturer's specifications. Acceptance of the equipment or material shall not constitute a waiver of this requirement.
- Meet all applicable standards equipment providing communication for public transit systems, specifically including the following:
  - FCC rules and regulations, CFR 47 §90
  - TIA - 603 standards and specifications
  - MIL-STD-810E for vibration, shock, humidity, salt, and dust.
- Operate within the manufacturer's specified limits under all reasonably expected operational conditions.
- Capable of operation on narrowband (12.5 kHz) channels mid-bandwidth (NPSPAC) and wideband (25 kHz) selected on a channel-by-channel basis.
- Contractor’s shall certify that all equipment proposed has received the requisite certification from the Federal Communications Commission at time of Proposal submittal
- Equipment shall be fully solid-state, with the exception of any required relays, which shall be sealed
- All equipment and materials (with the exception of antenna cable and vehicular antennas used for testing) shall be new and unused, of the manufacturer's latest design, of current manufacture, the best of its respective kinds, and without defects in operation or appearance
- All equipment shall be equipped with lightning and surge protection, as appropriate, and shall be properly grounded in accordance with industry best practices.

- All equipment supplied shall be equipped with adequate fuses and/or circuit breakers, with time delay as applicable.
- Fixed-site radio equipment shall be mounted in 19” EIA-standard racks. Height to be determined by facility requirements. Vertical cable management shall be used as required with accessibility to both the front and rear. The racks shall be secured to the floor, have durable corrosion-resistant finishes, shall be earthquake-braced, and shall be separately grounded to the equipment room ground system.
- In areas that require additional security provisions, 19” locked cabinets shall be used.

2.9.2 Base Stations

The following sections describe the requirements for conventional and trunked repeater base stations and associated equipment for the new SFMTA radio system.

General Base Station Specifications

Base station transmitters and receivers shall comply with the most current version of:

- FCC Rules and Regulations, CFR 47, Part 90, Subparts R and S for 700/800 MHz operation
- TIA-603 standards and specifications
- TIA-102.CAAA-B and TIA-102.CAAB-B.

Each repeater base station at each site shall be equipped with an automatic station identifier to transmit the FCC call sign in Morse code at intervals of not more than 30 minutes, in accordance with FCC rules. System users shall not hear the identifier signal. The identifier shall be "polite," such that it begins during an interruption in radio traffic and, if interrupted, resets and attempts to send again, until such time that the complete message has been sent.

Transmitters shall employ a means of encoding a coded squelch "phase-reversal," or a digital turn-off code to eliminate the noise burst at the end of transmissions that would otherwise be heard by mobiles. Base station receivers shall also eliminate any noise bursts from being sent to the system, upon loss of signal from a field unit.

Base stations shall be arranged for automatic reversion to the "in-cabinet repeating" mode (for conventional channels) or to “site trunking” mode upon loss of the interconnecting link to the repeater site. In this mode, the base station shall instantaneously repeat the received signal, rather than sending it back to the audio processing equipment. Return to normal operation shall be under automatic control of the Radio Network Controller once the link is restored.

One complete metering package and microphone common to all base stations at a single site shall be supplied. This includes a local speaker and volume control to monitor all on-channel signals.

Base stations shall be equipped with visual indicators and contact outputs indicating malfunctions in transmitter output power, synthesizer condition, and AC and battery power-supply status.

The indication of failure of transmitter power and/or receiver operation shall be transmitted to the SMTs as an alarm.

Repeater base stations shall be frequency-synthesized and field-programmable. Transmitter and receiver modules shall be interchangeable between base stations.

Base stations shall be configured for operation from standard 120 VAC power.

Transmitters shall be equipped to provide a minimum power output of 100 Watts. The transmitters shall be capable of providing sufficient power to produce the licensed ERP (effective radiated power) level while operating at 80% of their rated maximum output power. In-service power shall be determined by coverage requirements and the Contractor's overall system design. The power amplifiers shall be capable of linear operation.

Transmitters and receivers shall be capable of being programmed in consecutive 12.5 kHz steps, to comply with frequency and modulation requirements of 47 CFR, Part 90. Base station transmitters and receivers shall comply with all requirements of 47 CFR, Part 90 Subpart R and S for digital operation in the 700/800 MHz bands.

Electrical & Mechanical Characteristics

Base stations shall meet or exceed the following requirements:

Base Station Transmitters	
Frequency range	764 to 776 MHz and 851 to 869 MHz
Programmable channel steps	12.5 kHz
RF power output	100 Wf, adjustable downward by 3 dB
Duty-cycle rating	Continuous (100%) EIA
Environment	-30 to +60 C 5% to 90% RH
Power requirements	-48 VDC
RF output impedance	50 Ohms
Oscillator frequency stability	±0.0001%, -20° to 60°C
Spurious and harmonic emissions	-60 dBc
Audio distortion	Maximum 3% @ 1000 Hz, @ 60% of full deviation
Audio response	Within +1, -3 dB of 6 dB per octave pre-emphasis from 300 to 3000 Hz, referenced to 1000 Hz

Base Station Receivers	
Frequency range	794 to 806 MHz and 806 to 824 MHz
Channel Spacing	12.5 kHz minimum
Power requirements	-48 VDC
Input impedance	50 Ohms
Sensitivity, 12 dB SINAD/Static BER (5%)	0.30 µV
Selectivity, EIA: 12.5 kHz adjacent channel	-60 dB
Intermodulation immunity, EIA SINAD	-80 dB
Spurious and image rejection	-90 dB
Service speaker input power	1 W @ +3% distortion, 1000 Hz
Audio response	Within +1, -3 dB of 6 dB per octave de-emphasis from 300 to 3000 Hz, referenced to 1000 Hz.
Audio hum and noise (at speaker output)	-45 dB
Line Output	Adjustable from -20 dBm to 0 dBm

Each base station shall allow local control using a common test set.

As a minimum, the test set (or base station equipment) shall provide the following controls and functions for local operations:

- Transmitter keying and modulation
- Local receiver audio volume
- Coded squelch encode and decode disable switch (affecting local and workstation)
- Coded squelch decode disable switch (affecting local speaker only)
- Repeater disable
- Intercom to Radio Dispatcher workstation (on voice channel only)
- Transmitter disable - effective in all modes of operation
- Line input/output disable switch for testing purposes
- Local control functions that could cause service interruptions shall be equipped with visual indicators.

2.9.3 Simulcast Equipment

This section shall apply only if the Contractor employs simulcast operation in its system design.

The Contractor shall be responsible for the simulcast performance of the integrated system, and shall provide equipment that will provide such performance.

The Contractor shall provide a method for automatic alignment of simulcast parameters from a central point in the network. This equipment used to perform the automatic alignment shall incorporate remote control capability to disable and enable individual transmitters for troubleshooting.

Simulcast frequency stability shall be maintained with the use of GPS receivers, rubidium clocks, or similar sources or standards at each simulcast site. A single spare source or standard shall also be provided.

The frequency standard equipment shall have the following design features:

- High-stability reference, capable of maintaining the 700/800 MHz transmitter frequency stability required for voice quality at the level of DAQ 3.4, and data transmission with BER $<10^{-3}$, with normal maintenance intervals of no more than once per year
- Operational temperature range of -30 to +60 degrees C
- Appropriate alarm outputs to alert the SFMTA's SMT and select dispatcher workstations of degradation or failure.

The system shall provide for maintaining the audio phase, delay, and equalization parameters necessary for high-signal-quality simulcast operation from the system central control equipment via the interconnecting network. The equalization equipment shall have the following design features:

- Delay equalization equipment shall be capable of adjustment in steps of 1 microsecond or less.
- Bulk audio propagation delay shall be controlled through an automatically adjustable delay line. The delay line shall be digital, and shall automatically adjust for changes in baseband propagation delay as a result of changes in the interconnecting network.
- Audio phase and amplitude equalization shall be controlled automatically. Alignment test signals that are transmitted automatically in the course of alignment shall not be heard by the users of the system.

Qualified Proposers shall describe, in detail, the proposed design from the dispatch console to the subscriber unit **[PRL 12-2-10 Simulcast System Design]**. In particular, discuss how your system design addresses:

- Method of providing transmitter stability
- Method of equalizing audio delays and audio levels
- Method of synchronizing RF transmit frequencies between all sites
- Requirements for site interconnection (i.e., microwave or fiber or leased T-1)
- Predicted simulcast distortion areas
- Method of optimizing and diagnosing simulcast system
- Description for all equipment items employed in simulcast system
- Contractor's experience in simulcasting digital trunked systems
- The use of the existing microwave and fiber infrastructure.

2.9.4 Comparators

A comparator for each radio channel per site shall be provided to accept and compare the received audio from the multiple base station receivers. Voted audio shall be sent to all primary and backup Radio Dispatcher workstation positions, and shall be simulcast from the base station sites. One spare receive input module and a spare comparator module shall be supplied. The comparators shall monitor all receiver circuits for continuity and automatically adjust for changes in line level.

Comparators shall also provide the following:

- On any transmission, the comparators shall make an initial comparison and selection within fifty (50) ms, and subsequent changes in selection within one (1) ms. as necessary to avoid disruption in the intelligible voice audio or the requirement for Digital Audio Quality of not less than 3.4
- The comparator shall differentiate between a weak signal with a high signal-to-noise ratio (or low BER) and a strong signal with a low signal-to-noise ratio (or high BER), and choose the former based on the performance specifications of the vocoder to achieve the required audio quality
- The comparator shall dynamically change receiver selections and have the range of receiver sensitivity and quieting required so that received signals with higher signal-to-noise ratio (or lower BER) are always chosen
- Controls at the comparator shall be provided to allow manual override of receiver selection and the disabling of any receiver line to allow a declared emergency to be received without any system parameter level interruption
- Indicators and controls shall be provided at the comparator to display the received signal status and to allow loudspeaker monitoring of each receiver line
- The comparators shall be capable of using a standard 3002-type line or a 4-wire E&M multiplex voice card to the connect to each receiver
- The comparator shall be powered by the 120 VAC backed up by the local UPS.

2.9.5 System/Site Controller

The digital trunking system shall employ a fault tolerant system of assigning channels at each site. This channel assignment controller may take the form of a dedicated trunked system controller or may be integrated in a control shelf in each repeater station. In either event, the controller shall be backed up with one or more redundant units at the primary site. The loss of the controller or supporting subsystems shall not result in the loss of trunking capability at one or more sites.

In addition to the channel assignment system, the use of a simulcast design may require the use of a master site controller system. This system would be required to maintain the database of system users and assign appropriate sites and channels on each transmission. This unit shall also be configured in a fault tolerant redundant arrangement so that the loss of any component or subsystem at any site will not result in the loss of site and channel assignment capability and will not result in the loss of trunking capability or simulcast operation at any sites.

If a backbone connection to a remote site in a trunked simulcast LMR system is completely lost, the remote site control electronics shall shut down the remote site until the backbone connection is restored unless other technology is employed to ensure that there is no RF interference to adjacent trunked simulcast LMR sites operating on the same RF channels.

Qualified Proposes shall describe how their design provides redundancy for the Prime Site and Dispatch Center including the following **[PRL 12-2-11 Prime Site and Dispatch Center Redundancy]**:

- Geographic redundancy in the system design
- Actions that must be taken to activate the back-up Dispatch Center.
- Impact on the system and subscribers when the Prime Site switches to the redundant site
- The impact on the system with the catastrophic failure of the building housing the Prime Site.

2.10 Antenna Systems

2.10.1 Antennas

The selection and design of base station antenna systems along with transmitter combiners and receiver multi-couplers shall be the responsibility of the Contractor, and shall comply with the following requirements:

- Each antenna shall be equipped with a new, dedicated transmission line to the combiner or multi-coupler equipment
- All antennas shall be mounted so as to minimize the pattern distortion effects caused by tower members, transmission lines, other antennas, and other objects located near the antenna
- Receive antennas shall be mounted vertically above the transmit antennas with the maximum separation as space on the towers permits
- Antennas shall meet or exceed the requirements of Part I of EIA-329-A. Separate transmit and receive antennas shall be provided
- Antennas shall be high-quality, ruggedized models, designed for long-term, high-reliability performance under high wind conditions, and for minimal generation of passive intermodulation
- Antennas shall meet the wind and ice loading criteria as established in the local building codes.

The Contractor shall ensure that the installed antennas shall not exceed the maximum load of the tower. The Contractor shall perform loading analysis of each tower or antenna structure that shall be used in the proposed design. In addition, a geotechnical analysis will be accomplished at each site, as applicable.

Qualified Proposers shall provide a complete description of the proposed antennas **[PRL 12-2-12 Antenna Description]**.

The Contractor shall provide complete description of the antenna systems provided **[CDRL 12-2-12 Antenna System Equipment Description]**.

The Contractor shall provide, under seal of a licensed California Professional Engineer, an antenna tower loading and geotechnical analyses **[CDRL 2-13: Antenna tower loading and geotechnical analysis].**

2.10.2 Use of Tower Top Preamplifiers

Tower top amplifiers may be used. If used in, the design for repeater base station equipment configurations, the Qualified Proposer shall demonstrate in its Proposal the need for such units, shall provide their performance characteristics, and shall demonstrate how they will be protected from overload and prevented from generating destructive intermodulation products in the typical high density RF environment that characterizes the majority of the SFMTA's service territory.

2.10.3 Transmission Lines

Cable selection shall minimize transmission losses to less than 10% of total transmitter power; this shall include all losses in the link from the station to the antenna.

Transmission lines shall be terminated in N-type connectors. Connectors shall be constructed of non-ferrous materials, and shall have gold plated inner conductors and silver-plated bodies. Premium performance, Type N male and female connectors shall be used for all transmission line connections.

Flexible cabling shall be used in short lengths where greater flexibility is necessary to terminate to equipment

Outdoor cable runs shall be continuous lengths, unless cable lengths exceed the maximum length that can be supplied by the manufacturer.

Six-opening entry port panels shall be provided and installed at repeater sites, if the existing panel cannot accommodate the new transmission lines. Entry ports shall be similar to existing ports at the site. The unused holes shall be capped and weatherproofed.

Antenna connectors shall be weather-proofed. Butyl-rubber tape shall be applied liberally to the antenna connector and protective coating shall be applied liberally over the butyl-rubber tape.

Each transmission line shall be protected from lighting and static discharges with an appropriate Transient Voltage Surge Suppression ("**TVSS"**) device designed with a voltage-handling capability for the quantity of 100 W transmitters required.

Antenna systems shall be grounded in accordance with industry best practices.

2.10.4 Antenna Support Structures

The site specific details of antenna mounting shall be determined by the Contractor during site visits. The Contractor shall be responsible to integrate the availability of support structures at each site and the Contractor's specific design. The Contractor shall, in conjunction with the SFMTA's Project Engineer, provide drawings of each antenna support for coordination with each site manager.

The Contractor shall design and install all tower support structures in accordance with TIA-222(G) or the latest revision.

2.10.5 Transmitter Combiners

The selection and design of transmitter combining equipment and arrangements shall be the responsibility of the Contractor.

The transmitter combiner system shall comply with the following general requirements:

- The transmitter combiner design shall include all frequencies specified herein at all radio sites. The combiner shall be capable of expansion to accommodate additional channels in the future.
- Isolator loads shall be sized to protect against damage to the associated transmitter (and isolator) in case of a transmission line or antenna failure at the output of the combiner that result in 100% reflection of the incident transmitter power from the associated transmitter.
- Interconnections shall use flexible, low-loss, hard-line-type cable
- The transmitter combiners provided shall meet or exceed the following technical specifications:

Transmitter Combiner Specifications	
Frequency range	**763 to 775 MHz**
Minimum isolation, Tx-Tx	**64 dB**
Minimum isolation, Ant-Tx	**50 dB**
Maximum insertion loss, per channel	**5.0 dB**
Maximum continuous power input, per channel	**125 W (minimum)**
Input impedance	**50 Ohms**
Maximum input VSWR, all ports	**1.25:1**
Minimum channel separation	**As determined by frequencies obtained at licensing and frequency sets used at each site**
Temperature range	**-30 to +60 C**
Connectors	**Type N female**

2.10.6 Receiver Multi-Couplers

The selection and design of receiver multi-coupling equipment and arrangements shall be the responsibility of the Contractor, recognizing that most radio sites on this project have significant ambient RF noise and numerous other active antennas. Receiver multi-couplers shall comply with the following:

- The receiver multi-coupler design shall include capacity for the current and future channel requirements at each site subject to Contractor verification of the SFMTA's radio system capacity requirements
- Multi-coupler systems shall be designed to limit receiver desensitization from the SFMTA or other co-located transmitters to no greater than 1 dB. The Contractor may be required to supply additional band-pass filters to reduce interference from nearby transmitters
- All unused ports shall be terminated with a 50-Ohm load
- Interconnections shall use flexible, low-loss cable
- The multi-coupler shall have a visual power supply failure alarm indicator with a Form "A" dry contact output.
- A fixed, isolated test port shall be provided
- The multi-coupler provided shall meet or exceed the following technical specifications:

Receive Multi-Coupler Specifications	
Frequency range	**764 to 824 MHz**
Power requirement	**-48 VDC**
Maximum noise figure, including bandpass filter(s)	**4.5 dB**
3rd-order intercept point	**+34 dBm**
Minimum 1 dB compression point	**+18 dBm**
Minimum system gain	**2.0 dB**
Minimum Rx-Rx isolation	**25 dB**
Absolute intermodulation suppression	**-120 dBm, with two -35 dBm input signals**
Temperature range	**-30 to +60 C**
Impedance	**50 Ohms**
Antenna input connector	**Type N female**
Receiver output connector	**Type N Female**
Maximum input/output VSWR	**1.5:1**

2.10.7 Other Antenna Systems

Control Station Antennas

The selection and design of control station antenna systems shall be the responsibility of the Contractor, and shall comply with the following requirements:

- A single, unity gain omni-directional transmit/receive antenna, with transmission line, shall be provided for each of the control stations provided.
- Antenna and polarity mounting method shall maximize RF isolation
- Installation of control station antennas shall be at locations coordinated with the SFMTA.

GPS Antennas

Antennas for GPS receivers and antenna mounting arrangements shall be determined by the Contractor and coordinated with the SFMTA. Hardware and installation shall conform to the overall requirements for reliable long-term performance.

2.11 Underground Design and Implementation

The City transit tunnels include the following:

- Market Street
- Twin Peaks
- Sunset
- Stockton
- Broadway (above ground tunnel, covered street level, buses)
- Presidio (above ground tunnel, covered street level, buses)
- Geary Blvd. underpass at Presidio Ave. (above ground tunnel, covered street level, buses)
- McArthur tunnel Hwy 1 (above ground tunnel, covered street level, buses)
- Yerba Buena Island (above ground tunnel, covered street level, buses).

The existing underground tunnels have street level track access via four (4) tunnel portals:

1. Ferry (Folsom to Embarcadero)
2. Duboce
3. West Portal
4. Eureka (abandoned station).

Additional coverage will be required in the general access areas of each station and egress routes. The Contractor shall coordinate with the SFMTA to identify these precise locations of these areas.

Radio coverage is to be achieved by designing and installing a combination of radiating cable with bi-directional amplifiers to propagate signal received from the outside network through the tunnels or from fiber optic cable connecting to fiber donor and remote units to distributing antennas that will be placed at strategically designed locations to distribute radio signal through the tunnels. The Contractor may propose alternative designs to meet this requirement. The alternate design shall meet the previously mentioned coverage requirements.

Qualified Proposers shall provide a complete description of their proposed underground system design for the above tunnels **[PRL 12-2-13 Underground System Design]**.

Qualified Proposers shall describe how the proposed underground design addresses the following issues **[PRL 12-2-14 Underground System Design Considerations]**:

- If a simulcast system design is used, how will the design mitigate TDI at the tunnel to above ground interfaces (i.e. portals)?
- How does the design allow for the future use of the radiating component of the underground system by commercial cell phone providers.?
- How will the design minimize the quantity of equipment installed in the tunnels?

The outside network signal may be received by donor antennas placed near the tunnel portals and connected to the donor fiber amplifier units or the donor bi-directional amplifiers feeding the radiating cable depending on which design option is chosen.

The radio coverage for the Stockton and Broadway open tunnels may be addressed with a receive and transmit antenna at each end of the tunnel with the receive being used to connect to the outside network signal and the transmit utilized to retransmit that signal through the tunnel sections to be received by radios operated inside or passing through the tunnels.

Underground system general requirements include:

- The proposed underground system design may use donor antennas, BDAs, leaky coax and distributed antennas
- Donor antennas may be placed at the 4 portals and Forest Hill station
- The system will include the entire run from Ferry to West Portal and the Sunset Hill tunnel
- The system will be designed for the SFMTA 700 and 800 MHz channels (licenses are found in **Appendix Eighteen (18)**)
- Where possible the BDAs should be mounted in the nearest station for ease of access.
- Where needed, the BDAs should be mounted on the wall of the tunnels
- The Contractor shall minimize the amount of equipment that will be installed in the tunnels
- All of the BDAs will be powered from a battery bank located in a room at the nearest station
- Power may be distributed to the tunnel BDAs via a 240 or 480 volt AC system
- The design shall assume complete new installation
- The new system shall be installed without removing the existing system
- The design of the underground radio system shall include an *actual power load calculation*.

The Contractor's design shall minimize interference at the underground portals and vent openings in the tunnels.

Underground drawings are included in **Appendix Twenty (20)** .The drawings found in **Appendix Twenty (20)** are included FOR REFERENCE ONLY and shall be verified by the Contractor during the design phase. To assist Qualified Proposer's in developing a cost Proposal, a fixed length of underground radiating cable has been included in the Cost Proposal Form.

The Contractor shall provide a complete design description of all underground communications systems including actual power load calculations. **[CDRL 12-2-14: Underground System Design Description]**

2.11.1 Radiating Devices

The Contractor shall design and construct an signal booster system to provide voice and data communications to meet the coverage requirements defined in section 2.3.6. The drawings in **Appendix Nine (9)** utilized a BDA approach. The drawings use a wideband Bi-Directional Amplifier (BDA) to boost the signal in the under ground area.

The system shall be designed on both 700MHz and 800MHz channels. In addition, the system shall be capable to handle cellular providers. The provider shall not be responsible to install BDA equipment for the cellular providers.

The Contractor shall be responsible to design the power to the BDA units. The SFMTA requires that the BDA shall be powered with 4 hour back-up power. The SFMTA prefers that this back-up power originate from the Station UPS.

The Contractor shall be responsible to determine the minimum gain of the **BDA to meet the coverage requirements of the SFMTA. The BDA shall have, at a minimum, the following specifications.**

- < 1µ propagation delay
- Maximum input level < 0 dB
- Maximum <+30 dB (single carrier)
- 120VAC or 240VAC
- < 100 W power consumption
- NEMA 4 enclosure
- Noise figure < 3.5dB.

2.11.2 Radiating Cable

The radiating cable shall be installed along the wall of the tunnel. The Contractor shall be responsible to install the radiating cable safely within the envelope of the tunnel. The Contractor shall design a method to attach the cable to the wall of the tunnel for the SFMTA review and approval. Underground tunnel clearance diagrams have been provided for reference in **Appendix Thirty (30)**.

Drawing SYS-05 shows the estimated cable distances for each tunnel. The Contractor shall be responsible to verify the lengths of each of the runs. In addition, the Contractor shall be responsible to determine the run lengths for the Stations and Emergency Egress Routes.

The radiating cable shall have the following, at a minimum, characteristics:

- Fire Retardant outer coating
- Operating band, minimum, 700MHZ – 800MHz
- VSWR < 1.3
- Copper inner conductor
- Attenuation (dB/100ft) <0.6
- Hanger spacing < 5 feet
- Distance from wall < 4.5 inches
- Bending radius, minimum 20 inches.

The Contractor shall ship the cable on cable spools in an upright position. No cable shall be accepted if the spools are shipped or stored on their sides. The Contractor shall be required to replace any cable stored in this manner at no cost to the SFMTA.

2.11.3 Structural Design

The Contractor shall be responsible for the safe clearance of the BDA enclosure with the trains. The train envelope is defined in **Appendix Nine (9).**

2.12 Subterranean Cable Car Machinery Structure Coverage

The SFMTA maintains several cable car machinery vaults, as shown in the drawing in **Appendix Nine (9)**. These vaults are located throughout the cable car service area and require portable coverage. This coverage is currently being provided by a single 800 MHz repeater at the Clay and Jones Building. The aforementioned performance reliability requirements shall be met in these areas using either the Clay and Jones site or other site. Qualified Proposer's are encouraged to recommend alternative solutions to the single repeater at Clay and Jones, thereby enabling the cable car machinery frequency to be used in the trunked pool and subscribers given access to full trunking features.

2.13 LMR Network Management

The mobile radio system shall be provided with a Network Management System (NMS) and associated System Manager Terminals (SMT). The NMS provides access to operational data and statistics for the trunked radio system. The NMS shall provide user access based upon a defined authorization hierarchy to be configured by the system administrator. The NMS shall provide the data and functions described in this section for the radio system as a whole, including data channels and trunked voice channels.

The core of the NMS shall be installed at one of the CCSF radio sites. The SFMTA recommends that the Bernal Heights site be the selected site. The Contractor shall provide SMT licenses for the following locations:

- All above ground communications sites
- Lenox Way Operations Control Center
- Radio Maintenance Shop located at 425 Geneva Ave.
- Turk St. Facility
- Green Facility.

The network management system shall provide for high system availability by monitoring the PSVRN system on a continuous basis through the use of automatic alarms, diagnostics, and interfaces to maintenance technicians through Contractor provided central monitoring equipment.

The radio system shall also provide a method for monitoring the use of the system through statistical reports by agency and for the system as a whole generated by network equipment on demand.

Qualified Proposers shall provide a complete description of the proposed LMR Network Management System **[PRL 12-2-15 LMR Network Management System Description]**.

The Contractor shall provide a complete description of the LMR Network Management System **[CDRL 12-2-15 LMR Network Management System Description].**

2.13.1 NMS and Component Subsystems

Subsystems critical to basic simulcast and trunking operation shall be located at the Bernal Heights facility.

Interconnection to the radio system sites and to primary dispatch facilities shall be provided via existing microwave or fiber optic cable. The Contractor shall review these existing facilities to determine their ability in support the Contractor's design. Use of leased circuits will require prior approval by the SFMTA post-award.

The NMS and associated sub-systems shall be connected to the AC emergency generator and UPS backup

All subsystems and associated subscriber units that constitute the PSVRN system shall be under control of a single network management scheme. The scope of the single network management scheme includes the five basic elements of network management:

- Configuration Management
- Fault Management
- Security Management
- Performance Management
- Accounting Management.

Implicit in the ability to manage these elements is the transfer of relevant managed object attributes that can be used, for example, to generate which managed information reports, alarms, management of system components and software levels, shall be able to be performed from a single point. This shall be accomplished in such a manner that an entry change to one database will automatically change all other associated databases without further user action.

Overall system management shall be able to delegate vertical partitioning management, which distributes the columns of a table into several separate physical records, to the organization responsible for the operation of the partition.

The monitoring of system performance and failures shall be described in detail in the Proposal. The Contractor shall describe system management procedures to the dispatch supervisor and radio personnel, at a minimum.

The system shall incorporate a graphical user interface (GUI) system manager/information management system to set selected parameters and allow the supervisory personnel to control and analyze system operation.

Critical failures should be automatically displayed to alert appropriate the SFMTA, CCSF, and Contractor radio personnel. If positive acknowledgement is not received within 30 minutes, then the system shall contact the SFMTA, CCSF, and Contractor maintenance personnel by alternate means (i.e. telephone, pager, e-mail).

The system shall provide to a single terminal, alarm conditions down to board level failures of all network elements.

Access to the management system shall be controlled through the use of an encrypted password (not displayed on the screen).

The system shall be capable of remoting a system manager user terminal without degradation of terminal performance. A remote user terminal shall be capable of performing /accessing all the same functions/information that a local terminal can.

The speed at which the remote terminal operates shall be equivalent to that of a local terminal and the accessing of information shall not be noticeably different in physical appearance or access time.

The Contractor shall provide the necessary connectivity to remote terminals.

The remote terminal shall be implemented so that a user has access to required system manager capabilities, which at a minimum shall include:

- System configuration—shall be able to control all of the programmable features of the trunking controller and radio infrastructure
- Subscriber management—shall allow an operator to view, set, or modify the talk group IDs, and the unique ID profiles
- Manager partitioning—System subscriber management functions shall allow user (agency) partitioning. Manager partitioning shall allow a user to view, set, or modify subscriber information pertaining to a particular agency while restricting access to other agencies. The highest level manager shall be able to view all subscriber information. Partitioning shall allow access to as well as prohibit users from different subsystems programming and system management areas, and subscriber ID ranges (talk groups and individual ID ranges).
- Diagnostic management—shall allow an operator to view current status and status history of the system. It shall also allow diagnostics to be performed on network devices (e.g., site controllers, base stations, comparators).
- Dynamic radio commands—regrouping of system users, including the ability to predefine, store, and implement regrouping plans as needed. Sending and receiving of status messages to and from subscriber units. Selective radio status information regarding radio operating status (i.e., on/off, inhibited), last talk group affiliation, and last site registration
- Selective inhibit/un-inhibit of control stations, mobile and handheld radios and trunked repeaters
- Subscriber equipment shall be equipped to respond to the system manager commands
- Activity reporting by unit, talk group, department (if available), and systemwide
- User database maintenance with automatic sharing of data and updates between the console electronics and the trunking system
- Activity monitor to display the status and activity of all RF channels of the active prime site controller
- Capability of automatically updating the backup site controller when database changes are made

- All user terminal positions shall be equipped with system printers to print activity reports or other output produced by the SM/IMS
- The printers shall be high-speed HP Laser Jet units or their equivalent.

2.13.2 Network Management System Functions

The NMS shall be a comprehensive system of software and hardware, backed by the expertise needed to incorporate network information into a complete management tool.

The NMS shall eliminate the slow turnaround of management data, reduce the time and effort spent deciphering network alerts, and provide the facts needed to make effective management decisions, while easily accommodating network growth and the addition of new technologies.

The Qualified Proposer shall supply detailed information on products and descriptive system solutions as part of their Proposal.

The Contractor's response to the NMS shall show an understanding of the SFMTA's requirements for design and integration of the radio network along with each of the systems and the associated elements needing monitoring and control.

Contractor supplied solution(s) shall be tailored to this RFP and the specifications. Other RFP specifications defining the mentioned systems shall be considered by the responding NMS Contractor in order to fully understand the overall issues and requirements of the NMS.

The NMS shall be developed with an emphasis on customizable graphical displays and simplified interfacing to various networks.

The NMS shall be of a modular structure providing end-users with the capability to expand the base system by choosing from a diverse selection of optional software applications.

The software supporting the NMS shall respond to network expansion by enabling modifications to the NMS as new devices are added or deleted.

The NMS shall be provided as a turnkey system.

The Contractor shall supply the software and the hardware, coordinate the entire installation, create the initial graphical representations of the network, perform acceptance tests, and conduct NMS system administrator and end-user training.

The NMS shall be a multiuser, multitasking, multinodal system with customized and interlocked access, monitoring, and control functions per entity.

The SFMTA envisions the NMS to be composed of the following systems: system manager and core NMS equipment at the Dispatch Center, remote user terminals at other remote locations, and network elements, element managers, remote terminal units (RTU) and other Supervisory Control and Data Acquisition (SCADA) elements at the remote radio sites.

2.13.3 Radio Subsystem Manager Considerations

The Contractor shall provide radio subsystem managers that allow the system manager to monitor and manage the radio subsystems.

These radio subsystem managers shall also be supplied in such a manner as to allow alarms and control functions from the radio subsystems to be passed to a remote terminal that monitors the entire integrated radio network.

The Contractor shall provide detailed information describing this functionality of the radio subsystems and the connection/access between the radio subsystem element manager systems.

2.13.4 Radio Subsystem Monitoring

The radio subsystem shall provide the capability to automatically monitor the following infrastructure components on a 24-hour basis:

- Communications links to base station sites
- Base stations
- Base station controllers
- Servers.

2.13.5 Radio Subsystem Management Services

Management services shall include the following:

- Automatic radio system infrastructure component fault and failure detection and alarm generation
- Audible and/or visual alarm operator alerting
- Diagnostics for isolating and troubleshooting faults and alarms including all communications links and link equipment
- Message volume statistics by radio channels per hour
- Message volume statistics by base stations per hour
- Message volume statistics by subscriber units per hour
- Thirty-day alarm history log file(s)
- Remote dial-in service support capability.

2.13.6 NMS Alarm Monitoring

SMTs shall display alarms from all radio sites indicating the following conditions at a minimum:

- Transmitter output power
- Synthesizer condition
- Loss of audio
- Power supply faults
- Door intrusion
- Smoke
- High temp
- HVAC failure
- Commercial power loss
- Generator on.

2.14 Dispatch Equipment

The dispatch system shall provide closed channel operations for revenue vehicles, in conjunction with the selective calling features provided by the MTMS (**Appendix Twelve (12), Section Three (3)**). The dispatch system shall provide open-channel operations for non-revenue users on the trunked voice channels.

The primary radio system control functions shall operate in parallel with, and be capable of independent operation from the automatic radio system controls of the MTMS to allow for independent operation of the voice system should the MTMS become inoperative.

The SFMTA prefers that primary radio control functions be provided via software that runs on the Dispatcher workstation. All such workstation positions that support voice communications shall also include all appropriate workstation-mounted equipment, such as PTT switch, select and un-select loudspeakers, receive volume controls, and headset jacks. PTT floor switches are not acceptable.

The PSVRN and MTMS shall include all required desktop communications equipment necessary for PTT voice communications to the vehicle Operators from each of the workstation positions, including backup workstation positions.

Radio Dispatcher workstations shall provide a visual and audible indication of service-affecting trunked voice system failures. This may be a summary alarm simply indicating that the system has experienced a failure; specific details need not be provided as these would be evident on the SMTs from the system technicians.

It shall provide, at minimum, the following functions:

- Voice channel selection
- Select indicator
- Mute
- Mute indicator
- Channel busy indicator
- Transmit indicator
- Microphone
- PTT switch
- Receive audio volume controls
- Select and non-select loudspeakers
- VU meter.

Qualified Proposers shall provide a complete description of the proposed dispatch system **[PRL 12-2-16 Dispatch System Description]**.

The Contractor shall provide complete description of the dispatch system provided **[CDRL 12-2-16 Dispatch System Equipment Description]**.

2.14.1 Radio System to MTMS Interface

The operator console/central electronic systems shall have the capability to interface directly with the MTMS for the performance of all control, status, and monitor functions, as well as the running of system diagnostics.

The radio system messages, alarms, and status information shall be capable of being forwarded by the console controller system to the MTMS using open system protocols and a comprehensive interface facility.

Qualified Prposer's shall identify the types of interface protocols and methods that will be used to interface the radio system to the MTMS. The SFMTA desires an IP based interface.

All the control functions of the operator consoles shall be capable of being integrated into the MTMS client workstations through a IP-based network connection.

All direct inbound radio messages, control functions, and diagnostic information shall be capable of being forwarded to the MTMS system through a network connection using open system protocols.

All console system control, management, and security functions shall be capable of being controlled by an external network interface using open system protocols.

Specifically, the radio console systems shall be capable of seamless integration with the MTMS, including but not limited to, the following:

- Decoded inbound radio unit ID and the emergency ID messages
- Selection of any of the equipped talk group/channels, multiple talk group/channels or pre-assigned group of talk group/channels for transmit operations at any authorized network workstation
- Hardware ID number and the alphanumeric ID of any unit transmitting on the system
- System alarms and system status records
- System error records with any deviations from standards indicated
- Talk group/channel busy on the related talk group/channel
- Monitoring from all talk group/channels, whether transmit selected or not
- Priority talk group/channel markers from any of the talk group/channels controlled by the system
- Repeater control capabilities at all consoles
- Cross talk group/channel patch capability on any of the talk group/channels from all of the consoles

- Single login for operator position provided by the MTMS system with a minimum of four levels of security
- Ability to perform select audio or un-select audio functions
- Ability to perform transmitter control functions
- Predefined status messages generated by subscriber units. These messages shall be displayed on the operator consoles and delivered to the MTMS system interface. A minimum of eight different status messages per discipline shall be supported.

2.14.2 Console Features

At a minimum, each dispatch console shall provide the following features, functions, and equipment that:

- Incorporates high quality design standards specifically to support the reliability required for critical public safety operations
- Meets or exceed all applicable FCC, TIA/EIA, IEEE, and APCO standards
- Incorporates the requirements of the TIA-102 P25 Console Subsystem Interface(CSSI)
- Supports a state-of-the-art design using distributed processing topologies
- Provides separate electronics bank(s) with surge suppression and redundant power supplies
- Incorporates continual and automatic diagnostics and comprehensive reporting systems
- Includes digital audio processing
- Provide to integrate the telephone and radio audio into one (1) headset
- Incorporates modular construction throughout circuitry and electronics banks
- Facilitates full interoperation between trunked and conventional systems
- Interfaces to single and multiple site trunked and conventional systems
- Provides access and control of single and multifrequency stations
- Provides full capability for individual channel and talk group controls and access
- Provides one gooseneck microphone per position
- Provides dual headset connections
- Facilitates interconnection with the PSAP's administrative and E911 telephone systems for answering and interconnect capability
- Provides dual pedal PTT foot switch
- Provides 12/24 hour clock and month, day, year, status

- Facilitates interface to logging recorders, instant call check devices (trunked, conventional, and telephones) and master time source generators
- Provides one liquid crystal display (LCD) flat panel monitor of at least 18 inches for each dispatch operator position with appropriate human interface device (touch screen, and/or trackball, or mouse)
- Facilitates cross-patch function between trunked talk groups and conventional channels
- Provides simultaneous-selection capability (All-Points Bulletin) of various talk groups or channels
- Provides multiselect capability of various talk groups or channels
- Provides multiple alert tone generation
- Incorporates programmable paging encoders and single button paging capability
- Allows monitoring of designated facility and radio system alarms
- Provides select and unselect speakers with volume controls
- Decodes inbound radio unit ID and the Emergency ID message and routes the ID to all consoles for display and activates the appropriate audio alarms at the consoles
- Allows only one console operator to transmit on a channel/talk group at a time
- Displays a busy indicator on the related talk group/channel at all consoles
- Displays call indication on all inbound channels/talk groups
- Provides for console monitoring of all talk groups/channels
- Allows a priority channel marker to be placed on any of the talk groups/channels controlled by the system
- Displays the alias names of individual radio units and system ID's
- Provides intercom capabilities between operator positions
- Monitors receivers
- Incorporates main and standby power sources
- Provides for remote dispatch position capabilities
- Provides auxiliary input/output interfaces for auxiliary functions as well as audio recording of voice traffic on base stations
- Provides complete network management and message activity system statistics.

Qualified Proposers shall describe the following for their proposed console system **[PRL 12-2-17 Console System Design Considerations]**:

- How to implement a hot standby dispatch center and prime site. A Hot Standby site would be used to provide catastrophic redundancy to critical components of the system. Backup servers are usually installed in the same rack as the primary or in an adjacent rack.
- Can the backup servers/equipment be physically remoted to another location to increase survivability?
- Describe your firm's experience in interfacing a CAD/AVL to the radio system and console system
- Explain the architecture of the console system and integration of the CAD/AVL with LMR radio system(s).

2.14.3 Operator Control Capabilities

The operator console positions shall provide, at a minimum, the following functions, features, and capabilities:

- All console operator positions shall be capable of dynamically reconfiguring a console for single channel/talk group or multichannel/talk group operation with easy access to setup changes. A color graphic display of multisized channel/talk group control modules is acceptable for channel selection. Displayed radio modules shall be capable of rearrangement by a telecommunicator by work shift or tactical situation. During a console reconfiguration, an active console shall not be taken off-line or lose communications with a selected channel, talk group, or telephone line.
- Any operator console position shall be capable of automatically selecting and displaying a transmit/receive channel(s)/talk group(s) or preselected group(s) of talk groups/channels with a single control up to the maximum number of active channels at the console.
- Any primary control function shall be executed with no more than a single operation or keystroke on preselected talk groups/channels, e.g., multiple channel or group transmit selection.
- All operator console positions shall be equipped with identical control layout capability. The talk group/channel assignment capability for all consoles shall be identical. A control operation shall always be performed at the same location on the control panel or display screen at all consoles.
- Status of all selected channels/talk groups shall be visible to the operator at all times, e.g., transmit selected, busy, call, selected receive audio, unselected receive audio.
- An error in a system entry by a console operator shall activate an audible warning and cause an error message or indication to be displayed.

- The console design shall allow any console to transmit and receive on one or more transmit/receive channels/talk groups, up to the maximum number of active channels/talk groups at a console.
- All consoles shall have the ability to transmit an alert tone of 900 Hz, 1000 Hz, and 1500 Hz over the air for as long as the alert tone switch is depressed. Pulsed variations of this single tone shall be provided. The tones shall be transmitted over any selected talk group/channels.
- As an option, the Contractor shall provide operator headsets. Each of the operator console positions shall contain two hand- and foot-operated PTT switches. The PTT foot switch shall be capable of operating in parallel with the operator console PTT switch. The foot switch shall be heavy duty, designed for constant use, and shall be designed so that it will not skid on a smooth flooring surface. The Contractor is to supply and install a switch for each operator position. The hand PTT shall be part of the operator's headset and mountable onto a belt.
- The operator shall be able to access the radio system and the administrative telephone system via the headset. The administrative telephone may be independent of the console system.
- Each console shall transmit on a talk group/channel on a first-come, first-serve basis. All other consoles shall be locked out from transmitting on that talk group/channel until the first transmission is completed.
- All consoles shall be provided levels of priority transmit to allow override of transmissions on any talk group/channel in an emergency situation.
- One VU meter shall be provided on the desktop unit of each operator console position.
- Two freestanding loudspeakers are required at each console; one each for select and unselect audio paths. Additionally, a minimum of one speaker/audio amplifier shall be provided at each console position. Each speaker/audio amplifier shall be capable of receiving up to four audio inputs and shall have independent volume control. These inputs shall be capable of dispatcher selectable automatic muting during any transmission on any talk group/channel.
- The Contractor will provide and install a wall-mounted transmitting indicator that will be conspicuously positioned within the communications center and will illuminate indicating radio talk group/channel activity.
- The Contractor will provide and install a console-mounted transmitting indicator that will illuminate indicating radio activity on each operator console.

2.14.4 Console Controller

The console controller design shall utilize the latest distributed microprocessor based technology. Computer systems, both software and hardware, shall be proven and reliable, consistent with the rigorous usage prevalent in the public safety environment.

The console controller as provided shall incorporate a reasonable expectation of support throughout the life of the voice radio system.

Sufficient access space for front and rear servicing shall be contemplated and provided in the space plan for the equipment room. The Contractor shall provide information regarding the recommended floor space and the proposed footprint, to scale, for the proposed central electronics equipment and associated hardware.

The central console controller system shall contain the various microprocessors, controllers, base stations and receiver interfaces, operator console interfaces, auxiliary function interfaces, and other interfaces or components necessary for proper and efficient system operation. The interface controller circuit cards shall be mounted in card cages provided by the Contractor. All controller circuit cards shall be of plug-in design and shall be able to be inserted and/or removed from the card cages with both power applied and the system on-line.

Each transmit and receive interface card shall incorporate all necessary circuitry required to operate remotely controlled base stations, trunked and conventional repeaters, and trunked and conventional simulcast repeaters.

At a minimum, each interface shall consist of a plug-in circuit card that may contain control-related circuitry, line driver amplifiers; two-wire and four-wire receive amplifiers, digital automatic level adjustment circuitry and fault diagnostic circuitry. The module shall be capable of remotely controlling base stations using industry standard tone remote controls, E & M signaling, and/or DC remote control.

The Contractor shall specify the required connectivity for their console and console controller solution. The Contractor shall also indicate the type and capacity of the connectivity solution.

If a LAN is proposed, the Contractor will specify what capabilities, capacities, and equipment are required so that the SFMTA may determine if other LANs to be placed into the new communications center may facilitate this need. The Contractor shall identify any constraints that may be present if the LAN was to be shared with other systems, such as E911 telephony, CAD, logging recorders, or other information technology systems that require LAN connectivity.

2.14.5 Console Telephone Support

The console design shall allow each of the console positions to have headset and control capabilities to operate the voice radio system and a telephone device supporting administrative telephone systems.

Administrative telephone equipment and radio shall be selectively operated through a single headset worn by the Dispatcher. The call transfer feature shall automatically hold the telephone call and route the dispatcher's audio to the selected channel/talk group whenever the operator depresses any PTT control switch.

The radio audio shall be routed to the select audio speaker whenever a telephone call is in process so that the dispatcher can effectively communicate with the telephone caller and with the radio user simultaneously.

2.14.6 Console Reliability and Diagnostic Features

Due to the critical nature of the communications services provided, the communications control consoles and the console's central controller must achieve a high degree of reliability. The systems shall provide continual and automatic self-testing and diagnosis:

- Be automatically fault correcting
- Alert the operator in the event of component or subsystem failure
- Allow continued operation in the event of failure of a console subsystem through isolation of the defective subsystem
- Provide a high degree of modularity to reduce the number of subsystems affected by a single component failure
- Allow repair of subsystems without totally disabling the console system, as continued console operation is necessary during repair.

The Contractor shall recommend the appropriate level of spare modules and parts needed to promptly restore the console or central electronics to full service following subsystem failure.

Recommended spare modules and parts shall be listed as individual items inclusive of model or part number, description, and cost. These costs shall be part of the system pricing sheets.

The central electronic assembly shall be interfaced with the system/management terminal to supply comprehensive system statistics and diagnostics identifying console subsystem failures and for the purpose of making service-related inquiries.

2.14.7 Fault Tolerance and Redundancy

The console controller system design shall provide for system redundancy including subsystems and associated equipment, such that no single point of failure can affect the entire system. The console

controller shall be designed in configurations that prevent the occurrence of a catastrophic system failure because of a single point failure.

The consoles and console controller shall provide for continued system operation in the event of almost any type of failure. The communications center audio and control circuits shall be continuously tested for proper operation. Equipment shall incorporate features that allow continued function in degraded modes following major equipment failures.

Duplication of circuits necessary to attain this performance shall be provided. No single failure shall entirely disable more than one radio talk group/channel or one console, and the loss of one operator position shall not affect system operations.

All critical system components shall be duplicated to form a backup system supporting automatic changeover that will prevent loss of an operator position, a radio talk group/channel, a call in progress, or the system status. Failure of any data bus shall cause an automatic transfer to a redundant bus structure. A failed module shall be isolated from the system bus structure and readily identifiable as needing service.

The console central electronics design shall provide a redundant configuration with one active central controller and one hot standby central controller. The failure of the active controller shall cause the automatic transfer to the standby central controller with no disruption to any portion of the system. To avoid an undetected shelf failure of the standby central controller, the active controller shall continually run fault diagnostics on the standby unit.

The distributed microprocessor design shall provide multilevel redundancy as each operator position and field circuit shall be capable of independent operation. The failure of any one or more or these units shall not affect normal system operations.

Card replacement, if applicable, while the system is operating shall not disturb system operation or cause damage to an electrical component. A new card shall automatically duplicate the characteristics of the card replaced.

Integral power supplies shall be fully redundant, such that if a power supply failure occurs, it will automatically switch to the backup supply. Reserve power supplies shall be maintained in a cold-standby mode for isolation from transient spikes or surges.

System design reliability shall include on-line spare equipment, redundant system controllers, redundant communication path, and other redundant equipment as necessary to improve reliability. Redundancy is mandatory where any failure will be catastrophic (loss of transmit or receive functionality for voice or data). System design is as critical as the selection of components.

Where redundancy is employed, malfunctions will not be considered system failures if the system is restored to full operation within 2 seconds or less. System failure is defined as any malfunction that causes loss of system or subsystem to depart from acceptable standards.

Qualified Proposers shall provide the following dispatch equipment information **[PRL 12-2-18 Dispatch Equipment Fault Tolerance and Reliability]**:

- Any potential single-point failures that will result in a degraded mode of operation.

- How the proposed design will support system reliability requirements for dispatch system facilities with a minimum life expectancy of 15 years from the date of system acceptance
- The projected system reliability and mean time between failure (MTBF) for major subsystems and equipment, based on the system proposed
- The proposed system design's major elements and describe how the system will react to a failure of each major element.

2.14.8 Operating Statistics and Reporting

The console controller shall provide channel utilization information to be accumulated by an integral database repository. This statistical information shall be available for printing in the form of statistics to benefit management operations. The reporting systems shall support the transfer of information into commonly used word processing and/or spreadsheet/presentation applications software for further analysis, presentation, and reporting.

Reports shall include, at a minimum, information in the following categories reportable by console position and/or radio talk group/channel:

- Total uplink transmissions per channel
- Total downlink transmissions per channel
- Total elapsed time of uplink transmissions per channel
- Total elapsed time of downlink transmissions per channel.

Information collection intervals shall be variable up to a frequency of one (1) minute. The information collected shall be transmitted to the records database at the end of each interval. Elapsed time measurements shall be accurate to a tenth of a second. Information collected shall include date and time of day. Information shall be stored in an industry standard format compatible with the aforementioned common applications.

2.14.9 Maintenance Operator Console

The console controller system shall incorporate a maintenance operator console that will provide information and configuration access to communications system diagnostics, alarms, and monitoring functions. This console position is envisioned for installation in the dedicated equipment room adjacent to the main dispatching floor and will primarily be operated by the SFMTA's radio technical staff.
The technical staff operating the maintenance console shall be provided with the capability of monitoring the functional status of the new system, verifying the proper system operation, responding to system alarms, and performing necessary system diagnostics.

Visual and audible alarms shall be provided at the maintenance console. The alarms shall also be presented, at the SGMTA's discretion, at the dispatch consoles and appear on the designated supervisor console. Additionally, all console electronics alarms shall appear as a network interface to the MTMS.

Capability for displaying hardware ID numbers of radio units transmitting on each of the channels/talk groups shall also be provided and will be capable of being displayed on the maintenance console. Up to 10 IDs shall be available for display on any selected channel/talk group. A separate display of activated emergency ID numbers shall be provided.

2.14.10 Console Diagnostic Features

The system shall be equipped with a comprehensive set of self-diagnostic subsystems that shall continually monitor and verify the correct operation of each distributed microprocessor, each audio path in the console electronics (between the electronics and each dispatch operator position), and the system controller.

Diagnostic capability shall be distributed among independent and redundant subsystems and shall not rely on one central diagnostic circuit.

Each message on the console electronics digital data bus shall include a Cyclic Redundancy Check (CRC) or its functional equivalent.

All data messages between the console controller and individual dispatch positions shall include checksum security measures.

The console controller equipment shall periodically run audio diagnostics through each transmit and receive audio path in the system. The audio paths shall include the automatic audio level setting circuitry and the line coupling transformers. Should a fault be detected, the designated supervisory console and the maintenance console shall be notified through a user friendly English language display. Fault minimizing routines shall be automatically activated and diagnostic information shall be logged on an associated system printer or to an applicable storage device/repository for subsequent reporting.

Diagnostic messages shall be presented in an easy-to-read text format, which shall enable non-technical dispatch personnel to intelligently evaluate the situation and minimize disruption to normal operations.

Diagnostic systems that require the personnel to cross-reference an error code to a fault message are not acceptable.

2.15 Digital Logging Recorder System

A Digital Logging Recorder System (DLRS) shall be provided for simultaneously recording, at a minimum, the trunked voice traffic of the PSVRN and the telephone lines at each MTMS Dispatch position. The DLRS shall record the date/time and channel information to identify the information being recorded. The DLRS shall be capable to connect to a LAN system and handle a minimum of twelve (12) clients. The DLRS shall interface to analog audio input signals and convert these signals to a digital format for storage on both non-removable disks and record-capable DVDs.

The DLRS shall include a PC-based display and control unit that may to be located remotely from the recording equipment. The equipment to be furnished under this Specification shall be designed for continuous operation 24 hours per day, 365 days per year. The DLRS to be supplied by the Vendor shall produce high fidelity recordings of the SFMTA's voice traffic and provide the features and functions listed below.

Qualified Proposers shall provide a complete description of the proposed Digital Logging Recorder System **[PRL 12-2-19 Digital Logging Recorder System Description]**.

The Contractor shall provide a complete description of the Digital Logging Recorder System **[CDRL 12-2-17 Digital Logging Recorder System Description].**

2.15.1 Storage Media

The DLRS shall utilize record-capable DVDs or equivalent devices for the removable, reusable media to make copies for the SFMTA's purposes. Recording shall be performed at a compression rate of at least 13 kb/s. The DLRS shall also supply a storage technique that allows for long term uninterrupted archiving without frequent manual updates, such as a Storage Area Network, to be provided by the SFMTA.

When the media being used to record communications becomes full or encounters a failure that prevents further recording, the DLRS shall automatically transfer to an available alternative recording deck. The DLRS shall continue recording all communications on the alternative deck with no loss of communications recording during the automatic transfer. The DLRS shall be equipped with sufficient recording decks to ensure that at least one year of communications may be recorded prior to a change of the archiving media. As a minimum, the DLRS shall be equipped with two removable media recording decks.

The DLRS shall also support storage of audio data to the SFMTA provided Storage Area Network resources.

2.15.2 Recording Channels

The DLRS initially shall record the PSVRN traffic and the telephone traffic at the MTMS Dispatch position. The DLRS shall be field expandable to support up to the equivalent of 48 analog or digital channels in the future.

The DLRS shall be designed to allow the audio inputs for each channel to be set for either current sensing, voltage sensing, VOX sensing, or switch closure, and be FCC approved for direct connection to the telephone system.

2.15.3 Playback

The DLRS shall provide the ability to multiple simultaneously playback any recorded channels and/or talkgroups from any archived DVD while recording of all channels is active on both a non-removable disk and one removable DVD or equivalent archiving media. The DLRS shall provide the ability to search, locate and playback the recorded information on specified channels and/or talkgroups at a specified date and time. The system shall also allow the user to go forward and backwards in a recording in order to locate a specific area of interest. The DLRS shall allow the time-synchronized playback of at least two channels and/or talkgroups simultaneously. The SFMTA prefers a design that allows the user to skip to the next or previous message in a recording during playback. A built-in speaker shall be provided for listening to the playback. Volume control of the speaker output shall be provided.

The DLRS shall also provide a software-based, LAN-accessible, instant playback recording (IPR) capability that allows access to at least the last 45 minutes of the most recently recorded audio from each Dispatch console. Date/time and channel selection shall be supported for the instant playback function. The instant playback shall be possible while audio recording is active and unaffected on all channels. The System shall be equipped to support at least five (5) clients for remote playback.

The DLRS shall provide tools to assist users to refine searches for audio.

2.15.4 Remote Playback

The DLRS shall provide Users the ability to playback the current recorded data residing on the Recording System non-removable media from any authorized computer connected to the SFMTA WAN using a software-based instant playback application. Using this application, the remote user shall be capable of selecting the recorded messages by talkgroup, console or phone line. The user shall be capable of saving portions of the recorded data to the hard drive of the remote computer. The format of the saved data shall be in a ".wav" or similar file format. This shall allow the remote user to be able to forward the data segment to other agencies, as the user deems appropriate.

The remote playback application shall appear as an icon on the users PC screen. The remote playback shall be capable of a default channel configuration. This will allow the user to select the playback button and easily and quickly listen to a conversation. The application shall allow the user to select a non-default channel for monitoring.

Any remote user shall be capable of selecting any recorded conversation that is saved to the system hard drive without impacting the operation of the system.

2.15.5 System Display and Controls

The DLRS shall be configured for complete, local control of all voice logging recorder functions via a PC-based workstation station position placed in the Dispatch room adjacent to the recording media transport. This station shall display status and control information to the user and provide convenient controls that enable user to configure and control the operation of the Digital Recording System. This single display and control station provided by the Vendor shall support all 32 channels being recorded. It is not acceptable to use two or more display and control devices in order to support 32 channels. The information to be displayed to the users shall include but not be limited to the following:

- Recording status of each channel
- System status and functions
- Errors and alarms (including recording media errors, media full, etc.)
- Recording capacity remaining indicator
- Playback status of each channel
- On-line help
- Date/time
- Beginning and ending dates and times of the recordings on a particular removable media.

The controls to be supported by the DLRS shall include but not be limited to the following:

- Ready
- Record
- Play
- Select a channel to be monitored while recording is active on the channel
- Stop
- Eject
- Volume
- Set system date and time
- Rewind
- Search.

2.15.6 Equipment Mounting

The DLRS shall be rack mountable. The PC-based display/control equipment shall be mounted on a desk in the OCC.

2.15.7 Error Detection

The DLRS shall provide power-on initialization and self checking tests that are executed while the system is operating to ensure that the system is operating properly. A recording error detection also shall be provided. Any detected errors shall be displayed to the Dispatcher at the Dispatch Center and annunciated via an audible alarm.

2.15.8 Security

The DLRS shall restrict access to the system functions and controls via a multilevel password security scheme.

2.15.9 Write Protection

The DLRS shall provide a means for write-protecting selected removable media, such as a write once read many (WORM) DVD.

2.15.10 Variable Level Control

The DLRS shall provide a variable level control for each recording channel to permit operation within nominal levels between -40 dBm to +13 dBm.

2.15.11 Time Accuracy and Synchronization

The time indicated by the DLRS shall be accurate to +/- 10 seconds per week without external correction.

The time and date for the DLRS shall be capable of being set both manually by a user and automatically by an external time source or system net-time.

The DLRS shall include an interface to a customer-provided GPS time reference. The Digital Recorder System time shall be synchronized to this GPS time reference as often as necessary to maintain a Digital Recorder System time accuracy of +/- one (1) second. As a minimum, the Digital Recorder System shall be synchronized to the time reference once a day.

2.15.12 Operating Temperatures and Humidity

The DLRS shall be designed to operate over the temperature range of 5-40 degrees C and a humidity range of 20-80 % relative humidity, non-condensing.

2.15.13 Frequency Response

The DLRS shall be designed to record over a frequency response range of at least 300 - 3300 Hz.

2.15.14 Channel Isolation

The DLRS shall be designed to ensure that channel isolation is a minimum of 55 dB.

2.15.15 Distortion

The DLRS shall limit distortion to less than 3%.

2.15.16 Signal-To-Noise Ratio

The DLRS shall have a signal-to-noise ratio of at least 40 dB.

2.16 Equipment Installation Requirements

2.16.1 General

The Contractor shall furnish all tools, test equipment, supplies, and services necessary to provide a fully operational and satisfactory communications system for the SFMTA.

The Contractor shall provide all the necessary personnel, tools, equipment, and transportation for the successful installation of all equipment provided.

The SFMTA may require that installation begin within 1 week of material delivery to the installing Contractor's location. The installation Contractor shall be prepared to begin installation at that time.

The Contractor shall ensure that all material and components are delivered to the proposed sites.

The Contractor shall be responsible for the security of all materials and components that are left at the proposed sites until site installation is completed and security measures are in place, such as fences, gates, alarm systems, etc.

The Contractor is responsible, and shall provide all hardware and supplies necessary for the proper and complete installation of all equipment. This includes bolts, clamps, wire wraps and other hardware, as required.

Installation shall include the removal, cleanup, and responsible disposal of existing radio equipment and ancillary subsystems that will be replaced under this procurement. The Contractor shall be responsible for disposing of all equipment, by certified equipment recyclers where necessary..

Optimization, trouble shooting, and adjustment of each subsystem shall be the Contractor's responsibility.

All existing radio communications systems shall remain fully operational during installation of the new system and until the SFMTA provides final acceptance. Because existing systems support current operations, interruptions in service due to the Contractor or Contractor activities cannot be tolerated. If interruptions in service are deemed by the Contractor to be unavoidable, prior written notification detailing the nature
and duration of such interruptions shall be provided to the SFMTA for review and approval.

Equipment shall be installed in a neat and workmanlike manner, in accordance with good practice, by competent technicians or installers.

Inspection and approval of all installations will be provided by personnel designated by the SFMTA. Such approval shall be limited in scope to the specific subsystem's physical installation, and shall not be construed to imply full acceptance of the system or subsystem.

Installation of equipment shall be performed by technicians holding a valid FCC general radiotelephone operators license, National Association of Business and Educational Radio (NABER) certification, or industry accepted equivalent.

Notwithstanding the details presented in these specifications, it is the responsibility of the Contractor to verify the accuracy of the material lists and suitability of devices proposed to meet the intent of the specifications.

The Contractor shall be responsible for providing or arranging for all parts necessary for the equipment and its installation up to and including final system acceptance.

Any equipment or parts required to provide a complete and operational system, and not specifically mentioned herein, shall be provided by the Contractor without any claim for additional payment. It shall be understood that the contract and agreement contemplate and require the “turnkey” construction and installation of a completely operational communications system that meets the SFMTA standards.

2.16.2 Communication Sites

The Contractor shall be responsible for installing all the necessary components associated with the communications system described in these specifications.

The installation of the RF equipment will be provided by the Contractor at the designated location(s) within the equipment shelters at the base station sites. The Contractor shall supply and install all required equipment, accessories, punch-blocks, terminal strips and/or cables needed to interface to new and/or existing facilities.

All audio and control cable/wiring to and from the radio equipment shall be shielded and grounded at both ends. Cable/wiring interfaced to the PSTN shall be shielded up to the demarcation punchblocks and shall have premium surge-supression devices installed and properly grounded at the shelter entry point and for each such circuit.

All external equipment intercabling, whether RF, AC, audio, or control cables and/or wiring, shall be labeled with preprinted, adhesive wire markers. Markers shall be placed at each end, adjacent to the connector, plug, or terminus. For cables and/or wiring within the shelter, markers shall be placed at 3-foot intervals along the length of the cable and/or wiring. This data shall be recorded in the installation documentation.

All equipment cables or cable bundles within the shelter, to the greatest extent feasible, will be neatly tied by means of plastic tie wraps and secured by clamps to flat surfaces.

Rack-mounted equipment shall be installed in standard equipment racks using minimal floor space.

All racks and equipment shall be installed to meet seismic 4. Equipment installed in locations without adequate security shall be installed in lockable enclosures to protect sensitive electronic equipment.

All cable/wiring bundles exiting the equipment shall do so through the top of the cabinets. If cabinets are used to rack equipment, rubber grommets or other suitable protection shall be used at cabinet knockouts to protect the cable/wiring. Splicing of AC, audio, or control cable/wiring will not be permitted.

With the doors closed, all Contractor-supplied equipment shelters shall present a sealed and secured enclosure to minimize the entry of insects and to prevent entry of birds, rodents, and unauthorized personnel.

2.16.3 Antennas and Transmission Lines

Each coaxial antenna transmission line shall be cut to length. The radio equipment end of this line shall terminate at a point, where the lengths of jumper cables are kept as short as possible. This terminus shall be secured to a wall, ceiling surface, or overhead cable tray. The ends of the transmission line shall not connect directly to the antenna, to any RF equipment interference protection, or to any combining/multicoupler/multiplexing devices. Connection to these devises shall be through the appropriately sized jumper cables.

All transmission lines shall be shipped with the spools on end. Any spool shipped or stored on its side shall be rejectted by the SFMTA and replaced at the Contractor's expense

The RF transmission line shall be fastened to the external antenna support structure in accordance with the manufacturer's specifications or every 4 feet for vertical runs. Fasteners and associated hardware shall be made of stainless steel and designated expressly for this purpose. Nylon cable ties are not acceptable.

RF transmission lines run inside equipment shelters or buildings shall be supported by a cable tray.

All transmit coaxial jumper cables shall be ½ inch diameter (similar to Andrew Superflex model FSJ4-50B) or approved equivalent.

Coaxial cables used within the shelters for receive signal distribution, such as receiver multicouplers/splitters may be sized by the Contractor to meet signal loss and flexibility specifications.

Jumper cables shall be used to interconnect all interference protection or combining/ multicoupling/multiplexing devices with the coaxial antenna transmission line and RF equipment.

Jumper cables shall be used to interconnect the antenna(s) to the top end of the coaxial antenna transmission line.

Jumper cables used to reach a side arm-mounted antenna shall be shaped to form a drip loop.

All jumper cables shall be cut to length and shall use type "N male" connectors except as dictated by the connector supplied with the antenna.

To meet cable-bending specifications for strain relief purposes, equipment cabinet intra-cabling will be permitted by the use of ¼-inch diameter foam coxial cable (similar to as Andrew Superflex FSJ1P-50A). These cables shall be kept as short as possible to minimize signal loss.

All coaxial cables exiting the equipment cabinets shall do so through cabinet feed-through similar to the Celwave model PD-395.

All connectors external to the equipment shelter shall be equipped with weatherproofing sleeves.

2.16.4 Grounding and Lightning Protection

The external commercial power feed to all new fixed equipment power supplies provided under this contract shall be protected by surge suppression devices with silicon avalanche diode type primary, with metal oxide varistors (MOV) backup.

All external radio control circuits, such as telephone lines to the new fixed equipment, shall be protected by surge suppression devices that are properly grounded.

All external coaxial transmission lines to the new fixed equipment shall be protected by gas tube surge suppressors that are properly grounded. The surge suppressor connectors shall be type "N."

All surge suppressors shall be placed at the point where the coaxial antenna transmission line connects to the jumper cable from the RF equipment and shall be grounded at the ground window, similarly to the Polyphaser Earth Entry Portal.

All RF and ancillary equipment supplied by the Contractor shall be grounded to the central ground bus.

All grounding interconnections shall be made by using #2 AWG insulated solid copper wire.

All coaxial antenna transmission line outer conductors shall be grounded to the tower. These grounding points shall be below the top connector of the line, above the point at which bends are made to exit the tower or antenna support structure, and at the lower end of the cable just above the point where the cable bends to enter the cable tray that runs from the tower to the shelter or building. This will provide a direct path to ground for lightning to follow without making any sharp turns.

The ground points shall be made by using the proper grounding kits from the same manufacturer as that supplying the coaxial antenna transmission line and in accordance with the manufacturer's installation practices. No grounding-to-tower cross braces is allowed; only direct conductor-to-site ground ring. Braided ground straps are not acceptable.

Cuts made in the outer jacket of the transmission line to install the ground straps shall be thoroughly sealed and weatherized per manufacturer's specifications.

Ground connections to galvanized tower legs shall be made with transition clamps, thereby reducing the oxidation effect of dissimilar metals.

2.16.5 Cable Terminations

Care shall be exercised in wiring to avoid damage to the wiring and equipment.

All wiring and connectors shall be installed in strict adherence to standard communication installation practices, manufacturer's recommendations, and all applicable federal, state, and local codes.

All cables, regardless of length, shall be marked and/or numbered at both ends**.** Marking codes shall correspond to recognized standards and specifications. All cabling shall be neatly laced, dressed, and adequately supported.

System wiring diagrams shall be prepared that show all inter and intra-rack connections for each site. This shall include all signal, power and ground connections. The diagram shall assign designators to all cables and connectors. The designators used shall be identical to those placed on the cables and connectors. The system diagrams shall also show all cable and connector manufacturers used and their part numbers.

All external equipment intercabling, whether RF, AC, audio, or control cable, and/or wiring, shall be labeled with preprinted adhesive wire markers. Markers shall be placed at each end, adjacent to the connector, plug, or terminus.

No splices shall be allowed in system wiring other than at approved designated locations and with approved devices.

Sufficient wiring shall be installed to provide required services to all locations in the CB with sufficient capability (minimum 40%) for future expansion.

To conserve space in the wall-mounted cross-connect backboard, small AT&T type "110" blocks may be used.

All terminations shall be clearly marked and labeled to allow rapid identification of every circuit in the Center and its termination point to facilitate repair or relocation of equipment.

2.16.6 Communications Console

The installation of the new console and associated equipment shall be provided by the Contractor at the designated location in the CB.

The Contractor shall supply and install all required punch-blocks, terminal strips and/or cables needed to interface the new console controllerto the existing facilities, such as radio equipment, telephone equipment, logging recorder equipment, and/or auxiliary function and/or control circuits.

All new console intercabling, including those that are to terminate at the existing punchblocks, shall be labeled with preprinted adhesive wire markers. The markers shall be placed at each cable end, adjacent to the connector or plug, and at 3-foot intervals along the length of the cable. All cables and/or cable bundles will be hidden from view and will be neatly secured by means of plastic tie wraps.

All intercabling to the operator positions and to the central electronic assembly(s) shall be provided with sufficient slack to permit movement of the operator position of at least 5 feet in any direction.

The Contractor shall provide a detailed transition plan that describes how the usres shall migrate from the existing to the new system. This transition shall not affect the daily operation of the SFMTA dispatch team.

2.16.7 Mobile Radio Installation Requirements

The following requirements apply to all mobile radio equipment to be installed on vehicles operating on the PSVRN.

As part of the mini fleet test, the Contractor shall install a prototype of each kind of vehicle operating on the PSVRN. The prototype shall be reviewed and approved by the SFMTA prior to installing the rest of the vehicle fleet.

All mobile radio installations shall be subject to inspection and approval before acceptance, by inspection personnel to be named by the SFMTA. Acceptance shall include but not be limited to:

- Appearance
- Effective usefulness
- Full programming as set forth by agreement
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables that shall be routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support device.

Ties to supports that are exposed to the weather shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

Wiring of the new equipment shall not be connected to existing radio equipment in the vehicle.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

In vehicles that employ electronic sirens or public address systems (PA), an audio output shall be connected to the siren for effective PA use through the siren speaker.

New radios shall be checked for compatibility with the PA at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment, at no additional cost to the SFMTA.

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle. The Contractor is to provide a detailed transition plan of how they will accomplish this while not affecting the current radio and antenna system on each vehicle. In vehicles that have no permanent metal roof (such as brush units), antenna type and installation are subject to the approval of the apparatus officer or his/her designee. Low-profile antennas, or antennas designed to work without a standard ground plane, shall be available as an option for these vehicles. The SFMTA understands that these vehicles may not exhibit as great a coverage range as normal installations; these vehicles shall not be used as the basis for coverage acceptance.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power, or VSWR, shall be measured after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

It shall be the Contractor's responsibility to determine what vehicles require installation of a weatherproof mobile unit.

All mobile units installed in the fleet shall be of uniform type.

Radio units shall be easily moved from one vehicle to another, if required.

No wiring shall be spliced within the loom covering that wire.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any vehicle that experiences dormant operation battery drain, where such drain can be attributed to new equipment installation. The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

Acceptance of mobile installation shall not imply acceptance of the radio system.

2.17 Options

Qualified Proposers shall provide a complete description of all proposed radio communications systems options **[PRL 12-2-20 Radio Communications Options Description]**.

The Contractor shall provide a complete description of all purchased radio communications options **[CDRL 12-2-18 Radio Communications Options Description].**

2.17.1 Over the Air Programming (OTAP) Option

The Contractor shall, as an option, provide a system that allows the SFMTA to remotely reprogram the template of subscriber units. The Contractor shall provide a growth path to allow the SFMTA to add this feature in the future.

The Contractor shall provide a description of the components and software that are required for this feature to operate on the radio system. The Contractor shall provide a description of how OTAP operates. This discussion shall include, but not limited to, the following concerns:

- Impact on system capacity
- Impact on CAD/AVL polling
- length of time required to program a radio using OTAP.

2.17.2 Over the Air Rekeying (OTAR) Option

The Contractor shall, as an option, provide a system that allows the SFMTA to remotely rekey the encryption code of subscriber units. The Contractor shall provide a growth path to allow the SFMTA to add this feature in the future.

The Contractor shall provide a description of the components and software that are required for this feature to operate on the radio system. The Contractor shall provide a description of how OTAR operates. This discussion shall include, but not limited to, the following concerns:

- impact on system capacity
- impact on CAD/AVL polling
- length of time required to program a radio using OTAP
- how many codes can managed by the system
- management of the codes.

2.17.3 Encryption Option

All voice and data channels on the system shall be capable of end-to-end encryption from a radio dispatcher workstation to a subscriber unit or subscriber to subscriber. The encrypted communications shall not decrypted at any step in the communication process except at the subscriber or dispatch units. Encryption shall be enabled and disabled manually via a switch or menu function on the radio and/or at the workstation.

Encryption shall not result in any degradation of the voice signal quality compared to a clear voice signal on a radio operating in the same circumstances and location as the encrypted radio.

Operation in encrypted voice mode shall be transparent to users, except that an icon or some other indicator on the mobile or portable radio and at the workstation shall indicate such operation.

Data encryption shall operate in a similar fashion, and shall also be transparent to the user, except that an icon or some other indicator on the mobile or portable radio and at the workstation shall indicate that the channel is operating in encrypted mode.

2.17.4 Intrinsically Safe Portable Equipment

Qualified Proposers shall propose, as an option, portable radio equipment with batteries and accessories that are intrinsically safe.

2.18 Proposal Requirements List

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

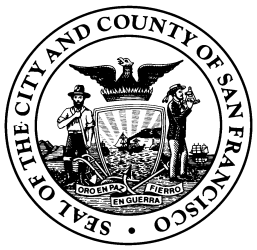
- PRL 12-2-1 Coverage Maps
- PRL 12-2-2 Failsoft Operation Description
- PRL 12-2-3 Failure Scenario Descriptions
- PRL 12-2-4 Backup Power Systems Description
- PRL 12-2-5 Coverage Maps
- PRL 12-2-6 Interoperability Design
- PRL 12-2-7 Desktop Control Station Equipment Description
- PRL 12-2-8 Link Budget Analysis
- PRL 12-2-9 Portable Equipment Description
- PRL 12-2-8 Mobile Equipment Description
- PRL 12-2-9 Vehicle Logic Unit Interface to Mobile Radio Description
- PRL 12-2-10 Simulcast System Design
- PRL 12-2-11 Prime Site and Dispatch Center Redundancy
- PRL 12-2-12 Antenna Description
- PRL 12-2-13 Underground System Design
- PRL 12-2-14 Underground System Design Considerations
- PRL 12-2-15 LMR Network Management System Description]
- PRL 12-2-16 Dispatch System Description
- PRL 12-2-17 Console System Design Considerations
- PRL 12-2-18 Dispatch Equipment Fault Tolerance and Reliability
- PRL 12-2-19 Digital Logging Recorder System Description
- PRL 12-2-20 Radio Communications Options Description.

2.19 Contract Data Requirements List

The following CDRL items are required, as specified within this section:

- CDRL 12-2-1 System Growth Plan].
- CDRL 12-2-2: Intermodulation Analysis
- CDRL 12-2-3: Tunnel Interference Analysis
- CDRL 12-2-4: Time Domain Interference analysis for the system
- CDRL 12-2-5 Air Time Traffic Analysis Report
- CDRL 12-2-6 Failure Modes Analysis
- CDRL 12-2-7 Coverage Analyses
- CDRL 12-2-8: Link Budget Analysis
- CDRL 12-2-9: LMR System Drawings
- CDRL 12-2-10 Desktop Control Station Equipment Description
- CDRL 12-2-11 Portable Equipment Description
- CDRL 12-2-11 Mobile Equipment Description
- CDRL 12-2-12 Antenna System Equipment Description
- CDRL 12- 2-13: Antenna tower loading and geotechnical analysis
- CDRL 12-2-14: Underground System Design Description
- CDRL 12-2-15 LMR Network Management System Description
- CDRL 12-2-16 Dispatch System Equipment Description
- CDRL 12-2-17 Digital Logging Recorder System Description
- CDRL 12-2-18 Radio Communications Options Description.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **three**

Intelligent Transportation System (ITS) Components

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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3.0 Intelligent Transportation System (ITS) Component

3.1 General Requirements

As part of Contract No. 1240, the SFMTA seeks to procure an off-the-shelf Multi-Modal Transit Management System (MTMS) consisting of Computer Aided Dispatch (CAD), Automatic Vehicle Location (AVL), and other Intelligent Transportation System (ITS) components to improve planning and operations of the SFMTA services. This system shall automate data entry and business processes. MTMS components shall include intuitive graphical user interfaces, directed navigation between application windows and screens, simplified data preparation and initialization, automated interfaces, and access to current and archived data and information.

The Contractor shall supply, license, install, integrate and implement the MTMS components on the SFMTA vehicles and fixed sites to provide continuous real time data of the location for revenue and selected non-revenue vehicles. The configuration of the MTMS on-board components shall include a Mobile Data Terminal (MDT) with an intuitive user interface and single point of logon integration, installed on each revenue vehicle. The MDT shall serve as the interface between the vehicle operator and the Control Center, and between the vehicle operator and other integrated onboard systems.

The MTMS shall include all hardware, software, and services necessary to accomplish the design, supply, installation, integration, documentation, testing, training, cutover, system acceptance and warranty of the complete MTMS. The MTMS configuration shall be based upon the SFMTA configurable parameters as required. These SFMTA configurable parameter values shall be propagated and used by all applications throughout the MTMS. Parameters shall include but not be limited to vehicles, operators, fleets, divisions, data messaging, communication settings, application settings, and operational thresholds.

Regardless whether integration options are included in the scope of work, the MTMS shall be capable of integrating with Automatic Passenger Counter (APC), automatic announcements, Automatic Vehicle Health Monitoring (VHM), electronic fare collection including the existing farebox and the TransLink® Regional Smart Card System, Traffic Signal Priority (TSP), and customer information systems.

The basic workflow for rubber-tire dispatchers and rail controllers shall be exceptions-based. Based on the assigned work, rubber-tire dispatchers and rail controllers shall be alerted when performance deviations occur, e.g. a vehicle running ahead of schedule beyond a SFMTA defined threshold.

Appendix Twelve (12) Section Two (2), "Radio Communications Components", describes the integrated Public Service Voice Radio Network (PSVRN) that the Contractor will implement, and that will support functions described in this section.

The Qualified Proposers and the Contractor must not assume the availability of communications components that are outside of the scope of the PSVRN. If proposed MTMS components drive the need for communications components to meet the requirements of this section, these communications components shall be provided by the Contractor. This applies to both voice and data communications.

3.2 Base ITS Components

The MTMS shall integrate the PSVRN, vehicle (onboard) systems, the dispatch communications, the CAD, and data system. Both data that has been generated in real-time and stored by the MTMS shall be available to the other SFMTA data systems and the general public, in a single, consolidated and overarching repository of that transit data. Query capabilities shall be provided that allow users to extract transit data from the repository.

The MTMS shall be designed to accommodate access to reports, data, system tools and applications to all user groups throughout the SFMTA. User groups include, but may not be limited to:

- Rubber tired and rail operations, including interim line management, dispatchers, train controllers, station agents, road supervisors
- Maintenance including rail mobile response units
- Traction power
- Security, proof of payment and emergency management
- SFMTA Management
- Planning
- Scheduling
- Information Systems
- Customer Service (311)
- Marketing and Communications.

Initial deployment shall include installation, licensing, and training support and system maintenance for dispatch workstations (including voice console capability) and web-based terminals throughout the SFMTA's facilities.

In the response to this RFP, the Qualified Proposers shall describe their software licensing terms in itemized form **[PRL 12-3-1 Software Licensing Terms].** The Contractor shall also provide licenses for data-only workstations capable of accessing the MTMS. The quantities are detailed in **Appendix Fourteen (14), "SFMTA User Work Station & License Requirements".**

The Contractor shall provide distinct sets of vehicle equipment for each of the SFMTA's modes:

- **Rubber tired diesel buses, diesel hybrid electric buses,** and **electric trolleys**.
  The Contractor shall provide a full suite of vehicle equipment, including options.

- **LRVs.** It is undetermined at the time of this RFP whether the Contractor shall integrate the new, but at the time of MTMS implementation, existing Digital Visual and Audio System (DVAS), or whether the Contractor shall provide an integrated on-board traveler information subsystem as part of the MTMS.
  In case the new existing DVAS shall be integrated, the Qualified Proposers shall propose a suite of vehicle equipment, including options, that is not already part of the DVAS.
  The vehicle equipment shall be capable to operate and provide all on-board functions when operating in multi-car consists and handle dual-ended operation of LRVs. In case a new DVAS shall be provided as part of the MTMS, the Qualified Proposers shall include an integrated on-board traveler information subsystem as part of their proposals. The details of this integrated on-board traveler information subsystem are described in **Appendix Twenty-Three (23).**

- **Cable cars.** The Contractor shall provide a limited suite of vehicle equipment for data communications which shall include automatic vehicle location. Some cable cars are dual-ended and the proposed equipment shall accommodate dual-ended operation. The cable car configuration shall not have any passenger facing or operator facing equipment, including control heads or MDT's, and operate without user interaction. The installed equipment shall not be visible to the public, and surveys and installation work shall not commence without the SFMTA's approval. The equipment selected for the cable cars shall accommodate the battery powered environment of the vehicles, and generally be of low power consumption.
  The Contractor is encouraged to replace existing equipment in place, with no, or only limited penetration of cable car structures, as approved by the SFMTA. In the instance of the cable cars, the use of commercial carriers for data connectivity might be acceptable. In- and outgoing data shall be processed such that records of cable cars, although possibly limited in scope of attributes, are seamlessly integrated with the MTMS. The selected standard shall be supported by multiple carriers to allow the competitive procurement of carrier services. This requires that the communications equipment shall not be locked to a single carrier, allowing the SFMTA to switch carriers by simply switching Subscriber Identification Modules (SIMs), or the equivalent thereof.

- **Historic street cars.** The Contractor shall provide a limited suite of vehicle equipment for voice and data communications which shall include automatic vehicle location. Some historic street cars are dual-ended, and the proposed equipment shall accommodate dual-ended operation. Installation and appearance of passenger facing equipment, if any, shall adopt the vehicle interior theme. Equipment enclosures that are visible to the public shall be consistent with the interior materials and color schemes. Incoming and outgoing data shall be processed such that records of historic street cars, although possibly limited in scope of attributes, are seamlessly integrated with the MTMS. The selected standard shall be supported by multiple carriers to allow the competitive procurement of carrier services. This requires that the communications equipment shall not be locked to a single carrier,

allowing the SFMTA to switch carriers by simply switching Subscriber Identification Modules (SIMs), or the equivalent thereof.

- **Non-revenue vehicles** will require equipment enabling voice communications, and selected non-revenue vehicles will require automatic vehicle location, emergency alarm, and service messaging through an MDT. Three variations of non-revenue vehicle configurations are specified in **Appendix Twenty Eight (28), "Cost Proposal Form"**:
  - **Configuration "A**" - refers to mobile voice only, including a mobile radio and control head. A portable radio charger shall also be provided.
  - **Configuration "B"** - adds to Configuration "A" by providing Automatic Vehicle Location (AVL) functions, through use of a Vehicle Logic Unit (VLU) and other necessary hardware to implement the AVL function, as specified below.
  - **Configuration "C"** - adds to Configuration "B" by providing a Mobile Data Terminal (MDT).

In the response to this RFP, the Qualified Proposers shall provide a comprehensive list of the major components of the proposed on-board equipment that is typical for each type of revenue and non-revenue vehicle. **[PRL 12-3-2 Major On-board Equipment Components List]**

Some vehicle types are articulated vehicles. In the response to this RFP, the Qualified Proposers shall provide a description about their approach and experience in equipping articulated vehicles **[PRL 12-3-3 Approach to Equipping Articulated Vehicles]**.

The following existing equipment shall be re-used on a per-vehicle basis, if it is fit for use in the MTMS:

- On-board speakers (internal and external) and cabling
- On-board signage: headsigns, side sides, tail signs and passenger facing run signs, including cabling
- Gooseneck microphone.

It shall be the Contractor's responsibility to make functional and integrate this existing equipment. Prior to installation of each individual vehicle, a pre-inspection shall be conducted by the contractor installation crew, recording and signing off on the condition of the vehicle and systems installed on it, including equipment that might be replaced under the above provision. A clear and legible statement shall indicate the reason for replacement. As part of final design, the Contract shall submit a pre-inspection procedure including pertinent work instructions and form for approval by the SFMTA **[CDRL 12-3-1 Pre-inspection Procedure].**

The following existing vehicle equipment shall be replaced:

- Covert alarm switch
- Covert microphone
- Vehicle operator loudspeaker and handset.

Existing connections such as EA button to camera surveillance system shall be restored.

As is a requirement for all equipment installed in this project, vehicle hardware shall be new, factory built equipment.

Vehicle Logic Unit (VLU)

The MTMS shall include VLUs that include the central processing unit (CPU), memory, data storage and vehicle software residing on each vehicle. As the central point of on-board subsystems integration, the VLU shall interact with all of the vehicle subsystems and support communications via a wireless bulk data transfer network with a central server. The VLU shall meet environmental and vibration standards (MIL-STD-810D, NEMA-4) as well as appropriate electromagnetic immunity standards (SAE 1455 and ESD J1112/13) and protect against surge, and reverse polarity. The VLU shall be of proven design and easy to install and replace.

Regardless whether the SFMTA elects to purchase any or all options specified in Section 3.29, the base VLU and MDT shall be capable of accommodating those options. In order for those options to be fully functional or, if such upgrades or changes are required, the Contractor shall be responsible for the implementation of these upgrades or changes. These upgrades or changes shall be carried out without service disruption to the SFMTA. All software updates needed to implement the options in the VLU shall be provided by wireless update.

The VLU shall be capable of multiple radio control, real time updates, and messaging to and from the vehicle. The VLU shall meet communication requirements for the wireless bulk data transfer network, radio, as well as interfaces for current and future onboard Intelligent Transportation Systems. The VLU shall control and electronically switch all interface audio paths.

Overall, system interfaces shall include RS232, RS485 with busy line, TTL, SAE J1708, SAE J1939, USB, Ethernet, TCP/IP, discrete inputs and outputs, odometer, spare I/O pins, audio inputs and outputs, and full IDE capability for PC-type devices. The capability for automatic vehicle monitoring via J1708/CAN provided by the vehicle OEM shall be included as an option.

Means for the quick inspection of the operation of radio keyed, wireless, wireless bulk data transfer, software, proper voltage range, and ignition on shall be provided. Data storage capacity shall be sufficient to store at least five operating days of passenger counts and all event messages in the case of data communications disruption. Sufficient data storage capacity shall be installed to store two sets of complete current transit network, schedule and operator assignment data, pending route schedules, five days of operating data, and associated announcement files with 50% spare capacity for long-term growth. MTMS configuration settings related specifically to the vehicle shall be stored in the vehicle's configuration module installed in the vehicle such that the VLU unit can be swapped out and the unique vehicle information automatically associated with the replacement VLU. Each VLU shall have a unique IP address for purposes of participating in the wireless bulk data transfer network, and for remote monitoring.

Regardless of whether the SFMTA elects to purchase any or all options, the base VLU shall be capable of accommodating those options. Purchasing any or all of the options shall not require any VLU firmware or hardware upgrades in order for those options to be fully functional.

Automatic Vehicle Location (AVL)

The Automatic Vehicle Location (AVL) subsystem shall provide a derived location using an on-board Global Positioning System (GPS) receiver and other location determination devices (e.g. Wide Area Augmentation System (WAAS), gyroscope, electronic odometer) as needed to provide automatic location accuracy within ten (10) meters of actual vehicle location. The use of active wayside components such as signposts, hub odometers, or obsolete technologies such as LORAN-C or inductive loops are not acceptable.
In the response to this RFP, the Qualified Proposers shall provide a description that specifies the accuracy of the proposed AVL subsystem **[PRL 12-3-4 AVL Subsystem Accuracy].** MTMS vehicle location shall be determined by a navigation algorithm that collects inputs from multiple sources and calculates a solution based on the reported reliability and weighting of each input device. Location determination devices other than GPS shall automatically calibrate and require no operator or maintenance personnel intervention for daily use. Proper operation of the onboard systems relying on location reporting shall not be interrupted for vehicles leaving from an enclosed storage area.

The GPS antenna shall be a low-profile unit housed in a rugged and weather tight enclosure. The GPS antenna shall be securely mounted and sealed on the exterior of the vehicle, clear of obstructions, and clear of interference from other devices or Radio Frequency interference. The GPS system shall provide a spare NMEA-string based GPS output that is made available over the Vehicle Area Network.

The GPS system shall have a cold acquisition time of no more than two (2) minutes, warm acquisition time of no more than fifteen (15) seconds and update the current position at least every five (5) seconds.
The GPS system shall include multi-path rejection capabilities to help eliminate inaccurate signals caused by reflections off of buildings or other structures. Vehicle location shall be transmitted at least once every one (1) minute to the central MTMS for display and storage purposes and every fifteen (15) seconds during an Emergency Alarm.

GPS delay time from location acquisition to formatting for transmission shall not exceed one (1) second. The GPS system shall store the most recent location to provide as the “last known good” location in the event that location reporting is interrupted. Location messages transmitted to dispatch shall indicate messages status as current, or “last known good”.

On board of the LRVs, location-based traveler information is provided to the passengers based on ATCS-triggered announcements. This is available when LRVs operate in auto mode within the ATCS territory. On-board AVL to drive AVL and all other functions shall be provided regardless whether trains are operating in auto, or cut-out mode. At the central side of the ATCS, parameterized data consisting of ASCII text messages is streamed via internet/telnet. This is factored in to the NextBus system’s predictive arrival information. By use of a parsing routine, the information can be made human readable for development use. The key to breaking out the parameters of each message resides in an AWK script file that can easily be imported for use by a programming language such as C/C++ or Java. MTA will supply the AWK file on request. The data provided includes time-stamped status reports on various objects in the subway. Messages are event-driven: for example, a message is generated when a train reports arrival at a station platform, doors are reported open, when doors are closed, and when the train departs the platform. It is possible to use this data to track any train through the subway. Many of the messages contain reference to logical location called a “track section”, which in turn can be mapped to geographic coordinates by use

of a reference table. MTA will provide the reference table necessary to make the conversion from track section to lat/long.

Given these existing capabilities, the SFMTA strongly recommends that this data stream be factored into the AVL subsystem to provide vehicle location updates to the central system, as well as to the vehicles operating in the ATCS territory, for a seamless integrate of the underground portions of the light rail system with the above ground portions.

Mobile Data Terminal (MDT)

The Mobile Data Terminal (MDT) shall be a color graphical screen capable of displaying fonts of variable size and adequate to display the relevant communications and Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) information to operators and maintenance technicians. The MDT shall be designed with appropriate functional buttons capable of controlling other onboard ITS systems (e.g. fareboxes, head signs, card readers) including a numeric keypad. For a hard key user interface, the MDT buttons shall provide tactile feedback for positive recognition of engagement. The user interface of a touch screen unit shall not require additional cleaning and provide positive recognition of screen taps.

The MDT shall provide contrast and brightness controls to provide for clear and easy viewing in day, night, or high glare conditions. The screen shall be scratch and glare resistant and accommodate users that use polarized lens sunglasses. The MDT shall be easy to install and replace, be durable, and be suited for use in the SFMTA's environment. Status and configuration data of all integrated onboard systems including GPS, communications network, discrete signals, passenger counters, farebox, wireless bulk data transfer network, applications software updates, and odometer, shall be available for query by a service technician. This function shall require separate authentication in order to lock out other users from accessing status and system configuration data.

The MDT shall display the vehicle's actual progress relative to the route pattern stops, and display schedule and headway adherence, depending which mode is active for the route. The MDT shall display the MTMS-determined time in a user selected format, including 24 hour and AM/PM presentations. The MDT shall display vehicle status including data transmission, pending messages, and communication mode to the regular user. The MDT shall have the capability to trigger individually different audible signals to identify the type of incoming service messages. The MDT shall be capable of providing onboard information and interface to onboard systems during operation of the vehicle including:

- Logon, integrated with Fare Collection (Cubic farebox and TransLink system) for a single point of logon
- Request-to-Talk (RTT) and Priority Request to-Talk (PRTT)
- Emergency Alarm (EA)
- Service messaging
- Transfer notification
- Schedule adherence
- Manual headsign control

- Automatic Passenger Counts
- Manual stop announcements
- Current trip and schedule
- Route
- Destination
- Operator ID
- Context sensitive on-screen help.

When the power is turned on, the MDT software shall automatically perform a power-on-self test, followed by configuring and initializing the MDT to the SFMTA-specified default values. The MDT shall be self-restarting and shall not become unresponsive or require manual restarts to continue operations. The MDT shutdown process will be controlled by the MDT software and shall only be possible when the ignition is in the off position.

A SFMTA configurable shutdown delay shall be provided to continue operations and to initiate the shutdown procedure that shall automatically close all files, save values, and send a shutdown message to be recorded in the MTMS system.

A warning shall be displayed on the MDT if a logon has not occurred after a vehicle is moved beyond a SFMTA configured distance outside of a yard. This warning shall be transmitted to the central MTMS for storage, and displayed on the dispatch workstations.

A logon process shall be provided for maintenance purposes to enable a vehicle to be moved throughout a facility for servicing and maintenance purposes without triggering alarms.

LRVs and other steel wheel vehicles are double-ended, and require multiple sets of vehicle operator facing equipment, including MDTs. The Contractor shall provide a full set of vehicle operator controls on each end of dual-ended vehicles.

The MDTs and VLUs shall be physically separated units. The MDT shall be designed for space efficient installation on the dashboard or other determined location, and minimize the number of cable runs needed. Power, and a data connection to the VLU, shall suffice to integrate and operate the MDT.

Single Point Logon

The Contractor shall integrate the existing farebox, existing ITS on-board systems (as required), and existing legacy systems with the MTMS in a manner that allows the vehicle operator to logon to the integrated on board systems, using the MDT only. The relevant data elements shall be derived from the operator logon procedure, and transmitted to the integrated on-board systems. The Contractor shall design the operator logon procedure and the derivation of the relevant data elements as part of the final design.

Operator input to the integrated system shall not be needed. The MTMS shall include a method to automatically detect trip changes within a block or train, and update peripheral systems (i.e. farebox, TransLink®, APC, etc.) with new trip information, as needed. The peripheral systems shall provide the VLU with fault and alarm codes. These fault and alarm codes shall be returned to the central MTMS via the wireless bulk data transfer network.

On the MDT, vehicle operators shall be prompted to enter the following data elements to log a vehicle on to the Computer Aided Dispatch (CAD) system: block or train number, run number, employee number, and fare set. These data elements shall be propagated to the integrated on-board systems, and drive all on-board functions without the need further intervention by the vehicle operator.

A log-over feature shall be provided that keeps block or train, run and fare set, but allow the entry of a new employee number only.

Integrated on-board systems shall remain easily accessible and maintainable, and existing diagnostics functions shall remain intact.

In response to this RFP, the Qualified Proposers shall indicate their approach and assumptions to provide the requested level of on-board integration **[PRL 12-3-5 On-Board Integration Approach].**

The SFMTA currently uses multiple vehicle types in five different modes. Existing revenue vehicle equipment is summarized in **Appendix Twenty Eight (28), "Cost Proposal Form"**.

The Contractor shall be responsible for the implementation, build, verification, validation, and installation of all subsystem interfaces.

Automatic On-Board Traveler Information System

The automatic on-board traveler information system provided by the Contractor shall use Automatic Vehicle Location (AVL) and logon data elements from the Mobile Data Terminal (MDT) to trigger the relevant automatic on-board traveler information throughout a block or train. The SFMTA's revenue fleet shall be equipped with automatic on-board traveler information systems as detailed in the mode specific sections below.

All existing and new on-board passenger displays and audio shall be under the control of the automatic on-board traveler information system. The network and schedule data along with announcement files shall be provisioned through the wireless bulk data transfer infrastructure at the divisions (yards) and other parking points that are equipped with a back-end wireless infrastructure.

The on-board sign shall display the following real-time information:

- Stop approaching
- Stop requested signal (initiated by travelers)
- Route and destination when doors are open
- Time
- Vehicle operator identification (name and employee ID)
- Public service messages, as set up and configured by the SFMTA. The frequency and duration of these messages shall be configurable by the SFMTA.
- On-board internal audible announcements shall mirror the on-board signs in accordance with the ADA.
- Route and destination shall be announced on the external speakers when the vehicle is at a stop or station berth, and the doors are open. The audio volume of external announcements shall be automatically adjusted by time of day, as configured by the MTMS system administrator.

If multiple messages need to be displayed simultaneously, the messages shall alternate on the on-board signs, based on rules specified and proposed by the Contractor and agreed upon by the SFMTA, prior to final design review.

The run number shall be displayed on the existing dashboard mounted, outward facing sign.

Audible automatic next stop announcements shall be transmitted through the on-board speakers (external, internal). The speakers are also used for passenger announcements by the vehicle operator or the control center. This drives the requirement to integrate the voice path infrastructure with the automatic next stop announcement system and the Contractor shall integrate all on-board voice paths relevant to traveler information (automatic and otherwise) with under the control of the VLU.

The SFMTA anticipates cases where manual intervention on board of the vehicle may be required to adjust or completely disable automatic on-board traveler information. A function to manually override announcements and sign displays shall be provided and controlled through interactions with the MDT (control head). This function shall be available to vehicle operators, however only when the vehicle is standing still.

Mode specific requirements: Rubber tired fleet

The SFMTA's rubber tired fleet is currently equipped with the Dynamic Vehicle Announcement System (DVAS). The internal, destination and run signs, as well as the loudspeakers (internal and external) shall be re-used, unless replacement is required due to defects. Whether replacement of existing equipment is required shall be assessed and recorded prior to any vehicle installation activity. In the response to this RFP, the Qualified Proposers shall include a contingency budget to cover the cost of these replacements. The existing DVAS equipment shall be decommissioned and removed, except for equipment that is needed to interface with the existing signs.

Mode specific requirements: Light Rail Vehicles (LRVs)

Currently, automatic passenger announcements are generated by the SFMTA's Advanced Train Control System (ATCS). This arrangement does not include on-board displays or any automatic on-board traveler information capability outside of the ATCS territory. The SFMTA is undertaking an upgrade to this system, installing a Digital Visual and Audio System (DVAS) on the LRV fleet. This system will provide internal signs and cover the entire LRV territory. The Contractor provided onboard systems shall interface with the DVAS through the interfaces provided by this system. The following functions shall be provided through these interfaces:

- Automatic triggering of announcements, based on logon to a block or train number
- Automatic triggering of internal sign displays, based on logon to a block or train number
- Automatic control of head- and run signs, based on logon to a block or train number
- Switching of the DVAS audio paths to connect audio sources such as the voice radio with the operator speakers
- Operator manual override of the above functions
- Operator manual triggering of announcements and setting of on-board signage
- Logging of triggered messages, for both automatic and manual manuals.

Mode specific requirements: Historic Fleet and PCC Street Cars

Automatic on-board traveler information is not required for the historic fleet and PCC Street cars..

Mode specific requirements: Cable Cars

Automatic on-board traveler information is not required for the cable car fleet.

3.2.1 Communications

Communications in the MTMS system shall be event driven. Active monitoring of screens and other devices shall not be required in order to allow the fulfillment of staff duties. A variety of message types shall be used to signal operational events

Emergency Alarm

The Emergency Alarm (EA) is a message type which is sent when the silent alarm is activated. Emergency alarms shall have the highest priority of all data messages. The EA event shall be transparent to anyone on the vehicle, except to vehicle operators. The EA button circuitry shall incorporate power-on-self-test features and have the capability to detect malfunctions such as open and short circuit conditions.
The on-board system shall report malfunctioning EAs as a vehicle health condition. The EA switch shall guard against accidental activation due to vibration, and shall have a guard to preclude accidental activation by the operator.

When a dispatcher receives an EA the following events shall occur, in sequence:

1. On dispatch workstations, an audio alarm is triggered and the vehicle is continuously traced on the AVL map display in a separate window. The refresh rate for location reporting shall be fifteen (15) seconds or faster, based on shortened vehicle location update reporting or polling.
2. An EA acknowledgment message shall be sent from the central system to the vehicle, and discreetly displayed on the MDT.
3. A dispatcher responds to the emergency by listening in to the vehicle through a “hidden” microphone integrated into the MDT or installed within the vehicle operator work area.
4. The dispatcher shall have the ability to downgrade an EA, if conditions warrant. This action shall be recorded and included in following reporting.
5. The dispatcher shall be required to fill out an electronic EA incident report. An EA event, downgraded or not, and the incident shall not be closed and is incapable of being dismissed until the EA incident report is completed.
6. The incident report shall be pre-populated to include time, date, vehicle location, operator ID, vehicle ID, and route (if applicable).
7. On board of the vehicle, the EA switch shall interface to the onboard camera system processor to allow the camera system to mark and protect the recorded video footage surrounding and including the time around an EA event. In case the camera system processor does not offer an input to connect the EA switch, a dry contact shall be provided that allows wiring the EA alarm into a possible future on-board replacement camera system.

The Contractor shall submit a complete description of Emergency Alarm Operation on board the vehicle, and from the dispatcher perspective **[CDRL 12-3-2 Emergency Alarm Description of Operation]**.

On-board Voice Communications

A loudspeaker, handset, magnetic hook switch, and armored cable shall be installed for mobile radio voice communications. The handset shall be located such that the cable is long enough for vehicle operator convenience without causing a safety hazard when not in use.

Vehicle operators shall be limited to pressing either the Request-To-Talk (RTT) or the Priority-Request-To-Talk (PRTT) function keys to initiate a request for voice communication with a dispatcher or train controller. The vehicle operators shall receive visual confirmation on the status of their RTT or PRTT. In the event the message could not be transmitted to the central system due to failure of the data communications subsystem, the VLU shall revert to voice fallback mode where the capabilities of the voice radio subsystem shall be used to communicate. It is understood that such communications may not provide the full functionality of the data communications system, but at a minimum, the MTMS shall include the capability to signal RTTs, PRTTs and EAs through the voice radio infrastructure. These messages shall be terminated on dispatch workstations and appear like calls issued through the data communication infrastructure. The fallback mode shall continue until the MTMS re-establishes data communications.

When a dispatcher, train controller or other authorized user initiates a voice call to a vehicle, the MDT shall issue an SFMTA configurable aural and visual notification of a pending individual voice call. Group calls and fleet calls from dispatch shall also be preceded by a notification, and the vehicle operator shall have the option of listening through the onboard speaker or by picking up the handset. The call types shall be distinguishable through different aural and visual notifications, as configured by the SFMTA. All switching and set up of voice communications shall be automatic without the need for manual assistance through the vehicle operator.

Transfer Requests

The MTMS shall provide an automated process to protect the transfer of passengers at designated transfer points. A vehicle operator may select a stop or timepoint and route to “hold” after receiving a customer request for a transfer. Upon selection, the MTMS shall evaluate the request and either approve or deny the request based upon allowable parameters. The maximum allowable hold time shall be definable by the MTMS system administrator.

The sending vehicle shall receive notification of the MTMS decision and if the request is approved the target vehicle shall receive a hold notification indicating the location and route to complete the transfer. The transfer request process shall not require dispatcher intervention. Using a transfer request display, the dispatcher shall have the capability to review transfer requests and intervene as deemed appropriate by the dispatcher. This display shall provide a function that allows dispatcher to filter by transfer status, including but not limited to failed and scheduled transfers.

3.2.2 Wheelchair Ramp or Lift Test

Wheelchair lifts and ramps shall be monitored and data recorded for each cycle. If a wheelchair lift or ramp is not cycled prior to leaving a garage/storage area at startup then the MDT shall display a warning to the operator and transmit the warning to the central MTMS for storage and display at the dispatcher workstation.

The Contractor shall submit a complete description of wheelchair ramp or lift test operation on board the vehicle **[CDRL 12-3-3 Wheelchair Ramp or Lift Test Description of Operation]**.

3.2.3 Vehicle Area Network/Wireless Router

The Contractor shall provide a vehicle area network wireless router that offers shared, standards-based access to communications infrastructure to existing and future on-board systems. There are on-board systems such as TransLink®, Automatic Passenger Counters and video surveillance that use their dedicated wireless networks. Integration of these existing system will not be required. Future systems that have a wireless network component however shall be able to use the vehicle area network wireless router to support their bulk data transfer needs. The vehicle area network wireless router shall be compatible with the wireless bulk data transfer network. On-board, the vehicle area network wireless router shall provide routing of IP-based traffic to and from the wireless bulk data transfer network. This wireless router shall support system segregation through Virtual LANs (VLANs), support IPSec VPN tunneling, include a deep inspection firewall, and provide the quantity of eight (8) One Gigabit Ethernet ports. The vehicle area network wireless router shall also be an on-board hub to distribute the following real-time information to complement existing stands-based interfaces:

- NTP System time
- Vehicle Health Monitoring and other discrete signals via port server
- NMEA GPS string, via port server.

While allowing bulk data transfer of connected systems such as the VLU, the wireless area network and wireless router equipment shall not place an undue burden on the on-board power supplies, in particular batteries. Remaining powered beyond the actual periods of wireless data transfer shall be managed such that vehicle batteries are not taxed and discharged.

The Contractor shall submit a complete technical description of the vehicle area network wireless router including provision for future interfaces. **[CDRL 12-3-4 Vehicle Area Network Wireless Router Description]**.

3.2.4 Computer Aided Dispatch

Computer Aided Dispatch (CAD) includes functions such as transit operations and information management, AVL map displays (including clear display of one way streets), data and voice communications management, and playback capabilities. The dispatch workstation with integrated voice radio console is the central organizing area for daily operations. The dispatch workstation shall be provided with at least two computer screens. Dispatchers and train controllers monitor vehicle communications and initiate actions according to the information provided on these screens.

The MTMS shall provide the capability for dispatcher assignments based on the SFMTA transit operating divisions, fleets, routes, vehicles, or the SFMTA configurable geographic regions. Distribution of un-assigned vehicles calls shall be to all logged-in dispatchers. A capability to configure all dispatch workstation to display and manage EAs shall be provided.

The dispatch workstation and integrated voice radio console configuration shall support voice communications with both a volume controlled speaker, microphone, and double headsets. A telephone system interface shall be provided. Audio path switch of speakers and microphones to radio consoles shall be integrated in the CAD user interface of the dispatch workstations.

The CAD software shall enable dispatchers to set pre-approved display preferences and enable those preferences upon dispatcher logon.

The CAD system shall ensure that the sequence of vehicles operating on a route shall be represented correctly. It shall not be acceptable that vehicles operating on a fixed track are tracked and displayed in an incorrect order at any time or location. In the response to the RFP, the Qualified Proposers shall describe the method to ensure the correct sequencing at places where routes converge **[PRL 12-3-6 Sequencing Routes Converge].** On a conceptual level, the Qualified Proposers shall include a description how this method would be employed at the West Portal entry to the Twin Peaks tunnel where routes converge, and at the Embarcadero turn-around, where some routes pass while others return outbound.

Light rail vehicles are operated in single and multiple car consists. The CAD screens shall clearly identify a multiple vehicle consist as a single operational unit, yet show the configuration of the consist.

The Contractor shall submit a complete technical description of the MTMS computer aided dispatch capabilities. **[CDRL 12-3-5 Computer Aided Dispatch System Description]**.

3.2.5 Control Center Voice Communications

Under normal operating conditions, voice calls to the fleet will be initiated by a dispatcher or train controller. The MTMS shall be designed to support this operating approach. The dispatcher shall be able to call based on manually or semi-automatically created groups: an individual vehicle, a group of vehicles, a specific route, geographic selection, vehicle operator ID, vehicle operator name, run, block or train, vehicles of a division, or all vehicles. The dispatcher shall be able to direct an individual call to the vehicle operator handset, vehicle operator loudspeaker, or the on-board public address system.

- Emergency Alarms shall have top priority and generate an audible alarm
- Dispatchers shall have the ability to select any call in the queue at any time
- Only one call request shall be retained and displayed when multiple call requests from the same vehicle are received determined by the request with the highest priority and oldest message
- For each call, the dispatchers shall have the option of opening an incident report.

The MTMS shall integrate all subscribers of the system and allow the dynamic formation of groups spanning across all types of subscriber units, as selected by dispatchers, train controllers and other users of the MTMS.

The users shall be able to contact the operator of the consist by a call the operator number, vehicle or consist number, the schedule block or train number, or the run number.

3.2.6 Service Messaging

The Contractor shall provide the transmission of service messages to manually or semi-automatically created groups. In case a subscriber unit such as a tier I portable does not support the presentation of service messages, these units shall be clearly identifiable in the dispatch and train controller user interfaces. Dispatch and train controller service messages shall either be keyed in as free-form text, or selected from a list of pre-defined canned service messages. The maximum length of service messages shall not be less than 128 characters. Standard service messages shall be configurable by the SFMTA. Dispatchers and train controllers shall have the option to require a vehicle operator acknowledgement upon viewing the message, and shall be able to monitor the status of message acknowledgement. The MTMS shall provide dispatchers and train controllers with the ability to send any service message designated as store-and-forward. Store-and-forward message duration shall be a dispatcher defined time period.

On board of the vehicles, the MDT shall allow vehicle operators to send service messages to central control, from a set of the SFMTA configured canned messages. The MTMS shall provide the capability for the SFMTA administrator to group messages into categories for quick selection by the vehicle operators. The MDT shall support the display of service messages longer than can fit on one line of the display, and a minimum of twenty-four (24) buffered messages shall be supported. Messages received from the central system shall initially be marked as unread. The service messaging shall support acknowledgement messages back to central control and send an acknowledgement message back to central control once the vehicle operator has acknowledged a message that the dispatcher or train controller previously flagged as requiring acknowledgement. Service messages shall be either deleted or saved by the operator after viewing.

The MTMS shall allow the SFMTA system administrator to configure messaging such that messaging is selectively enabled or disabled, including, but not limited to direction (call-in, call-out) and fleet type (LRVs, buses, trolleys). System administrators shall further be able to disable messaging based on the detection of vehicles moving, effectively disabling any messaging capability when the vehicle is moving. The SFMTA system administrator shall also be able to define message type routing to selected user groups, including but not limited to the routing of VHM messages to maintenance, as opposed to central control.

The Contractor shall submit a complete technical description of the MTMS service messaging features, capabilities, and administration. **[CDRL 12-3-6 Service Messaging Description]**

3.2.7 Textual and Tabular Displays

Basic dispatch textual capabilities shall be implemented in an easy to use and intuitive graphical user interface (GUI), and shall include the following basic functions:

- Multiple message queues for data messages, schedule and headway adherence, request to talk, emergency alarms, service messages, maintenance alarms, system health, and other event messages. The parameters for display and delivery of messages to users such as dispatchers and maintenance, shall be configurable by the SFMTA.
- Assignment of priority levels ordering and filtering by message type within the message queues
- Voice path options to switch to vehicle operator handset, vehicle operator speaker, or passenger facing PA speakers.
- Emergency Alarm listen in, audible alarms
- Schedule information by block or train number, run, vehicle, operator ID, including real time status of a vehicle
- Route information including schedules, vehicles and real time adherence status
- Pull-in and Pull-out status from the SFMTA divisions, including alarms for late and missed pull-ins and pull-outs
- Roster information for logging in/out of operators and assignment changes
- Remote vehicle operator logon or logoff by dispatchers and train controllers, with operator acknowledgement, if requested by the dispatcher or train controller
- Vehicle information indicating current availability, schedule adherence status and all other CAD/AVL tracked information
- Real time vehicle monitoring status including query capability for the history of vehicle health status messages. The real time vehicle monitoring shall include, but not be limited to the frequent vehicle updates (including accelerated vehicle location updates as required in Emergency Alarm situations), and vehicle health monitoring messages.
- Same day service adjustments for the addition, cancellation of trips, short-turning, and offsetting of trips. These adjustments shall be transmitted to the affected vehicles, and the affected on board functions, including but not limited to automatic on-board traveler information shall be adjusted accordingly.
- Off-route monitoring including both off-route and back-on-route notification
- Communication history for reviewing recent voice and data communications with the ability to create incident reports from within the history list
- Review of operator generated transfer requests and capability for dispatches to intervene in the transfer process as operationally required

- Detour description storage and display capability displayed by route with the capability to transmit detour notices as a service message
- Context sensitive on-screen help. Context sensitive on-screen help shall be made available to the different users of the MTMS, including but not limited to dispatchers, customer service agents, street supervisors.

In general, features that have been disabled for individual vehicles or fleet types, shall not interfere with the performance or operation of other features.

The Contractor shall submit a complete technical description of the MTMS textual and tabular display features, capabilities, and administration. **[CDRL 12-3-7 Textual and Tabular Display Description]**

3.2.8 Geographic Displays

Real-time mapping shall display the following functions in an easy to use and intuitive graphical user interface:

- Import and display of standard format vector, raster image, and point-based map layers
- Map layer feature labels provided based upon zoom level or with hover-over by a pointing device
- Continuously refreshed real-time updates of vehicle location and status
- Definition of multiple map views and ability to save at the dispatcher level
- Definition of shared views for use by any dispatcher to be saved in default set of views
- Zoom, move, center, and fit to window independent within each map view
- Filtered map views based upon parameters such as vehicles by route, login status, fleet, and mechanical status
- Map layer that includes current route traces for each fixed route selected by the dispatcher
- Options to display different vehicle icon labels including but limited to vehicle number, adherence, route number, vehicle operator ID, vehicle operator name, and run number per map view
- Vehicle icons that are configurable and contain context sensitive information that includes adherence, login, transfer, and maintenance status
- Query tools to locate vehicle and routes based on vehicle, route, operator, block or train number, run number, or intersection variables
- Capability to establish voice/data communication by individual vehicle or by banding a group of vehicles together

- Access to a distance measuring tool
- Print capabilities of any customized map view
- Automated focus and continuous vehicle tracking during an Emergency Alarm condition.

3.2.9 Schedule Adherence

The MTMS shall monitor schedule adherence by comparing actual vehicle location versus the published schedule for all vehicles logged into the MTMS. Schedule adherence data shall be stored and include parameters for analysis such as, but not limited to, vehicles, routes, timepoints, block or train, runs, and vehicle operator ID. Both the time of arrival and departure at all scheduled timepoints shall be accurately recorded and stored.

The SFMTA shall be responsible for providing the schedule data used by the Contractor-provided interface between the scheduling system and the MTMS. As part of the system implementation and throughout the duration of Contractor provided system maintenance, the Contractor shall perform the stop and route geo-surveys required to provide base data for the MTMS, using Contractor supplied tools. The Contractor shall also provide these tools to the SFMTA to enable the SFMTA to maintain this data after conclusion of the maintenance agreement, and provide training on the use of this tool prior to the conclusion of the maintenance agreement.

Real-time (predictive to a timepoint or stop) schedule adherence shall be displayed to the dispatchers and train controllers, and made available to customer information applications. The MTMS shall be capable of identifying vehicles that are predicted to be running early by more than a predefined number of minutes or late by more than a predefined number of minutes in real-time. The SFMTA shall have the capability to set schedule adherence parameters independently by route, with separate early and late user provided values.

The onboard MDT display shall be configurable to either inhibit display or display the predicted status relative to the schedule adherence displayed in one minute increments. If the MDT display is configured in the display mode, the schedule adherence display will be presented to the vehicle operator regardless of dispatcher selected parameters. Schedule adherence shall be calculated, tracked, transmitted, and stored regardless of the onboard display setting.

The Contractor shall submit a complete technical description of the MTMS schedule adherence functions, features, both on board the vehicle, from the dispatcher perspective, data maintenance, and reporting. **[CDRL 12-3-8 Schedule Adherence System Description]**

3.2.10 Ad Hoc Detours, Bus Bridges

The MTMS shall support central control in establishing and monitoring of ad hoc, same day detours and bus bridges. In the response to this RFP, the Qualified Proposers shall describe their methods of establishing and monitoring of detours and bus bridges as part of their system **[PRL 12-3-7 Detours and Bus Bridges Monitoring]**. At a minimum, these functions shall propagate the relevant information to all affected revenue vehicles, and adjust all affected subsystems to reflect the resulting operational changes of detours and bus bridges, including but not limited to automatic on-board traveler and other traveler information systems.

The Contractor shall submit a complete technical description of how ad hoc detours, bus bridges, and other service restoration features operate. **[CDRL 12-3-9 Detours and Bus Bridges Monitoring]**

3.2.11 Pre-planned Special Events

The MTMS shall provide the SFMTA planners with the capability to establish pre-planned events over a pre-determined time period. In the response to this RFP, the Qualified Proposers shall describe their methods for pre-planning events in terms of special revenue services, operational service messages and traveler facing messaging **[PRL 12-3-8 Special Revenue Service]**. This description shall also include a description how central control monitors special events during their duration. Special events shall also allow SFMTA to establish priority talk groups, readily available to central control for communication to vehicles and other subscribers, as configured by the SFMTA.

3.2.12 Route Adherence

The onboard MTMS shall detect off-route status and alert to the vehicle operator when off-route status is reached. This shall also be transmitted to central control for dispatcher notification. The off-route notification shall identify and include the name of the last known stop when a vehicle is further than a pre-defined distance from the assigned defined route. The off-route distance value shall be a MTMS system administrator definable parameter. The Qualified Proposer shall describe the applied process of how route adherence is detected, and the required base data to support this function. **[PRL 12-3-9 Route Adherence]**

The Contractor shall submit a complete technical description of how the route adherence features operate including notifications to dispatchers, detection, customization, and reporting. **[CDRL 12-3-10 Route Adherence]**

3.2.13 Daily Schedules

The MTMS shall hold network, schedule and assignment data for the current and one future scheduling period, and automatically be provisioned with the daily schedule of blocks or trains, runs, operator assignments, and vehicle assignments. The MTMS shall continuously support service that continues past midnight and service that overlaps in operating days, i.e. the MTMS shall support twenty-five (25) hour plus operating days.

Future schedules or assignments shall automatically be activated based on a SFMTA defined future activation date. Individual operating divisions may have schedule and assignment activation dates that are offset by several days. The MTMS shall accommodate selective activation of new schedule or assignment data by the SFMTA transit operating division.

The MTMS shall support multiple service types such as school in, school out, weekday, Saturday, Sunday, and holiday to accommodate service variations at the route and trip level. Each schedule day shall permit assignment of multiple service types. School day service may be called or cancelled only a day in advance, and the MTMS shall accommodate these short notice daytime changes.

The Contractor shall submit a complete technical description of how the daily schedules features operate. **[CDRL 12-3-11 Daily Schedules].**

3.2.14 System Administration

Throughout system implementation and the duration of Contractor provided system maintenance, the Contractor shall administer and tune the performance parameters of the MTMS and PSVRN systems. After conclusion of Contractor provided system maintenance, these systems shall be configured by an SFMTA system administrator, and as a minimum, the system administrator shall have the ability to change polling length cycle and number of retries, as well as all functions identified as “configurable by the SFMTA” throughout this RFP. The Contractor shall provide tools, documentation, and training to the SFMTA to put the SFMTA in a position to administer, tune, and verify the performance parameters of the entire system.

The MTMS shall enable authorized users to perform remote system administration and diagnostic analysis in a secure manner via VPN or remote terminal sessions.

The MTMS shall log communications failures and alert the SFMTA system administrators when excessive or system critical failures occur. The MTMS shall interface with the SFMTA’s electronic e-mail server via SMTP or other means to send users messages via e-mail or commercial wireless carrier text message. The Contractor shall specify the messaging of system failures as part of the final system design **[CDRL 12-3-12 System Failures Messaging].**

Alarms for critical hardware system failures shall also be communicated through the PSVRN's network management system **(Appendix Twelve (12), Section Two (2))**.

3.2.15 System Access Privileges

As part of the final system design, the Contractor shall identify the SFMTA user groups and access privileges to system functions such as administration, service messaging, diagnostics and voice communications **[CDRL 12-3-13 SFMTA User Groups and Access Privileges].** In the response to this RFP, the Qualified Proposers shall describe the management of system user roles and access privileges **[PRL 12-3-10 User Roles and Access Privileges]**, and as a minimum, SFMTA's system administrators shall have the ability to configure profiles for different classes of users through defined groups. The profiles shall permit system administrators to define access rights to applications as well as functions within applications. The system administrators shall be able to set permissions including any combination of read, write, change, and delete to applications and functions within applications.

The map, textual, and tabular displays shall be designed such that unavailable functionality based upon access rights and permissions are either hidden or clearly identifiable as not accessible. The map, textual, and tabular displays shall be designed such that unavailable functionality based upon access rights and permissions does not hamper the ease of GUI navigation within and between applications.

Settings that users can configure, within the limits of the user access privileges shall be saved upon exiting the MTMS CAD application(s), and restored in the subsequent user session.

3.2.16 Wireless Data Network

One of the primary goals of the MTMS data communications network is to support the command and control functions. The Contractor shall provide a robust data network that enables the SFMTA to minimize voice communications and support accurate real time information through periodic vehicle location updates and status messaging.

The Contractor shall provide all necessary hardware and software to interface to the SFMTA's Wide Area Network (WAN). The connection of the WAN to the MTMS shall be a trust relationship that isolates the MTMS network from the SFMTA or other City department WAN activity.

The Contractor shall specify the integration and separation of communications networks in the Final Design. In the response to this RFP, the Qualified Proposers shall describe their approach to communications network integration and separation **[PRL 12-3-11 Communications Network].**

The Contractor shall submit a complete technical description of the wide area wireless data network theory of operation and system description, including the software processes, polling algorithms, failure management, and statistical reporting. **[CDRL 12-3-14 Wide Area Wireless Network System Description]**

Throughput & Capacity

The wireless data network shall acquire the location of VLU equipped, powered-up vehicles within one (1) minute. Vehicles in EA shall be monitored in a shorter cycle. In the response to this RFP, the Qualified Proposers shall describe the proposed mobile unit polling algorithm, and the calculated time interval for the SFMTA's fleet size operating in revenue service **[PRL 12-3-12 Unit Polling Algorithm]**. Calculating channel utilization as a function of a fixed polling interval is not acceptable. Signaling such as RTTs, PRTTs and calling a vehicle from the control center shall not be based on polling, and be completed within three (3) seconds from initiation by the user.

The data subsystem shall provide the capability for fleet messaging, and provide the following functions:

- Schedule adherence
- Route adherence
- Request to talk/priority request to talk
- Emergency alarms
- Canned messages (inbound to central system and outbound)
- Free service messages (outbound).

The data protocol shall be robust and provide forward error correction, error detection, burst error protection, and verification of the delivery of critical data.

Automatic verification by the data network of message transmission completion shall be required together with automatic retries in the event of message failure.

Bulk data collection such as passenger counts and programming updates can be processed over a wireless bulk data transfer network when the vehicle returns to a division or other parking point.

The Qualified Proposers shall provide a load analysis, including data storage and bandwidth requirements **[PRL 12-3-13 Load Analysis].** Using the proposed data architecture, the analysis shall assume transmission of 1.5 messages each minute from each vehicle.

Wireless Bulk Data Transfer

The Contractor shall provide a wireless bulk data transfer network for data exchanges between the vehicles and the central MTMS at division facilities and vehicle parking points. The wireless bulk data transfer network shall be capable of transmitting data while the vehicle is moving in the coverage area of the wireless network.

The wireless bulk data transfer shall use and interface with the vehicle area network wireless router.

The wireless bulk data transfer network shall use the most current proven standards for communications and security (e.g. IEEE 802.11i), and use licensed spectrum. WiFi or similar unlicensed bands must not be used. Security provisions shall prevent unauthorized users from accessing transmitted data or gaining access to the SFMTA's network infrastructure through the wireless data system. In the response to this RFP, the Qualified Proposers shall provide the standards designed and incorporated into the proposed wireless bulk data transfer network **[PRL 12-3-14 Wireless Bulk Data Transfer]**.

The Contractor shall provide a wireless bulk data transfer network that meets the following criteria:

- 36 dBm EIRP transmit power
- -93 dBm receiver sensitivity at 3 Mbps
- NEMA 4 enclosure to sustain outdoor/mobile environments
- Layer 2 routing engine for faster route changes, low hop latency (less than 5ms) and complete transparency to IP layer.
- Lighter form factor less than 5 lbs
- Multiple Virtual LAN (VLAN) support for differentiated service
- 802.11e quality of service (QoS) support
- Ability to use 10Mhz 4.9G channels
- Gigabit backhaul and 10MBps wireless transfers.

The Contractor shall provide wireless bulk data transfer infrastructure at the following divisions and parking points:

- Woods
- Flynn
- Kirkland
- Potrero
- Presidio
- Muni Metro East (MME)
- Green LRV yard
- Islais Creek.

The wireless bulk data transfer network shall utilize licensed public safety 4.9GHz band frequencies. The Contractor shall apply for and obtain all licenses necessary to support the proposed wireless bulk data transfer network.

The SFMTA will finalize wireless bulk data transfer network installation requirements with the Contractor pending any changes to existing wireless bulk data transfer network infrastructures or facilities after contract award.

The wireless bulk data transfer network shall be available to all onboard MTMS equipment that requires the transfer of data files such as system-critical data, stored operating data, and firmware upgrades through the vehicle area network and wireless on-board router. Transfer of data files shall be by a proven standard protocol such as FTP. The Contractor shall provide software that uses a centralized method of transferring files for distribution to multiple division and parking points as listed above.

Data transfers shall be transparent to the user and occur whether or not the vehicle is logged into the MTMS. Vehicles shall be capable of receiving and sending data when in range of an access point at startup, shutdown, by a “wake-up” command (when the vehicle is powered down during off hours) issued by the MTMS, or at scheduled times. Wireless bulk data transfer network communication sessions shall be capable of being managed through an MTMS system administrator remote workstation to monitor, track, and verify data integrity on a vehicle-by-vehicle basis.

The SFMTA currently has wireless LANs (WLAN) in place for other systems such as the TransLink® and mobile video surveillance systems. Other neighboring wireless LANs may also impact wireless LAN performance. To avoid interference between different access points (and systems), the Contractor shall perform a wireless survey at each site, and ensure that wireless bulk data transfer network access is secure, has sufficient throughput capability, provides uninterrupted coverage, and does not interfere with other systems **[CDRL 12-3-15 Wireless Bulk Data Transfer System Surveys].**

Turning off vehicle ignition shall not interrupt the wireless bulk transfer. On-board systems such as VLUs and MDTs that utilize the wireless bulk transfer, shall be automatically managed such that components that actively use the wireless bulk data transfer are shut down after the completion of the wireless data transfer. Vehicle battery discharge to a degree that affect service and other on-board systems shall not occur.

Interrupted wireless bulk transfers shall be continued after wireless connectivity has been restored.

Vehicles entering wireless bulk transfer system covering while in service shall not engage the wireless bulk transfer, unless a planned layover allows for sufficient time for the required data exchange.

3.2.17 Data Communications Controller

The data communication system shall support connections from multiple the SFMTA departments and future additional City agencies while maintaining data integrity and security to allow different agencies, departments and divisions to use the RF data infrastructure while at the same time segmenting and securing each agency's data. The data communications system controller shall be capable of segmenting data, by department and agency, for the purposes of real-time CAD/AVL displays and off-line reporting.

The data communications system controller shall effectively manage communication resources in the area of where system subscribers and units operate, and provide the following features:

- Manage inbound and outbound data communications including supplying periodic loading information to the mobile units for hand-off and roaming coordination as needed.
- In overload situations manage Intra Site Load Balancing and command "hand-off" of selected mobile units from one channel to another to balance tower loads.
- Provide software fail-over capability in the event of a failure of any of the data communication channels by monitoring the health of all associated channels and provide input to the vehicles by broadcasting this information.
- Capability for "Store and Forward" functions when a mobile is in a transition state changing to another channel, "Firewall" function for all of the connected agencies and departments, and filters to insure that the data is delivered to the appropriate agencies and departments.
- Support base station hand-offs throughout the RF coverage area, which allows the mobile to transparently switch to different radio sites within the coverage area.
- Subscriber units shall support roaming as defined in their respective system protocols.
- Active and passive load balancing on channels on the same site if applicable. Passive balancing is done when a channel is determined to be in an overloaded condition as mobiles come onto the network. Active balancing is done as a result of a poll rate increase or failure condition.

- The data communications system controller must be able to provide message success rate coverage area reliability as required in **Appendix Twelve (12), Section Two (2),** for vehicles traveling at speeds up to 75mph.
- The impact of a loss in data radio connectivity on the fleet or individual vehicles and subscribers shall be minimized in a fashion that on-board automatic traveler information and AVL functions, including the logon procedure, remain functioning except for the discrete elements that require data radio connectivity for their proper operation. If other subsystem capabilities cover all or parts of the lost functionality, these subsystems shall be integrated such that their support is available to affected system functions.

3.2.18 Security

A security scheme that controls individual and group access management shall be provided that ensures a secure computing environment and limits access to authorized users.

The MTMS access shall require a logon process that includes a username and password. A database of all MTMS user access shall be maintained. Passwords shall be encrypted.

It is preferred that MTMS security management integrate with the SFMTA's active directory infrastructure for logon and access rights to features and functions within the MTMS.

The SFMTA definable groups shall set user access rights to restrict access to functions and set permissions for read, write, edit, and delete data at the group level. Users shall be allowed to be members of multiple groups with access and permissions determined by the highest assigned privileges.

Capability shall be provided to generate and print reports providing lists of the configured security groups, access settings, and user activity. Access from outside the SFMTA WAN/LAN shall be secured to prevent unauthorized users from gaining access to the SFMTA's network environment.

3.2.19 Interfaces

Throughout project execution, the Contractor shall control all interfaces through an Interface Control Document (ICD). Specifications that do not conform or that are not compatible with industry standards, shall be published, open, thoroughly documented and made available to the SFMTA for agency use in the implementation, operation and maintenance of the MTMS.

External Interfaces

On-board Destination and Run Signs Interfaces

The VLU shall interface with the existing destination and run signs. The VLU shall automatically send sign codes for every route and direction change during revenue service to set these signs accordingly. The MDT shall be capable of providing codes for the operator for manual selection of destinations and runs. This feature shall be available as a manual override to the automatic setting of displays. Vehicles that have manual curtain signs shall have an interface cable run from the VLU to a pre-determined area, coiled, and securely fastened in the event that electronic signs are installed at a later date.

Adequate protections and maintainability shall be provided to sustain cable runs that cross articulations and that run in other stressed areas, including LRV couplers, over the lifetime of the MTMS.

The Contractor shall submit a complete technical description of the onboard destination and run sign interface. **[CDRL 12-3-16 On Board Destination and Run Sign Interface Description]**

TransLink®

For reference, a portion of the TransLink® interface specification (as relevant SFMTA) is included in **Appendix 15, "Interface Control Document for Onboard Devices and the TransLink® Driver Console".**

The Contractor shall submit a complete technical description of the TransLink® interface. **[CDRL 12-3-17 TransLink® Interface Description]**

Farebox

The existing fareboxes, which are currently being refurbished, shall be integrated . The farebox interface specification shall be provided after NTP. The Contractor shall integrate the farebox, and shall receive and process farebox alarms. Farebox alarms shall be sent to the central system through the data communications network, to the SFMTA configurable recipient such as central control dispatchers, or maintenance. This alarm shall allow the SFMTA to raise awareness of farebox alarms in real time.

The Contractor shall submit a complete technical description of the farebox interface. **[CDRL 12-3-18 Farebox Interface Description]**

Existing Traveler Information System (NextBus system)

The MTMS shall interface with the existing SFMTA Traveler Information System (NextBus system). Data elements that are necessary to drive the existing traveler information system in its current form shall be sent from the MTMS. This implementation of the MTMS shall render the existing NextBus Tracker equipment on board of the revenue fleet obsolete.

As part of the vehicle installation with the MTMS provided equipment, the Contractor shall decommission and uninstall the existing NextBus Tracker equipment. In response to this RFP, the Qualified Proposers shall describe the data elements and methods of data transmission from the MTMS to the existing traveler information system **[PRL 12-3-15 Data Transfer to Existing Traveler Information System].** The Qualified Proposers shall also describe the cutover method from the existing tracker and ATCS interface inputs over to the MTMS interface **[PRL 12-3-16 Tracker and ATCS Interface Cutover].** The Contractor shall be responsible for all relevant licenses, design, implementation, and testing of this interface, including all work needed to update or upgrade the existing traveler information system, if necessary.

The Contractor shall submit a complete technical description of the NextBus system interface. **[CDRL 12-3-19 NextBus System Interface Description]**

MTC Real Time Information 511 Interface

The Bay Area 511.org system is a free phone and web service that consolidates Bay Area transportation information, including route, schedule, and fare information for the Bay Area's public transportation services. The 511.org web site is the Bay Area Traveler Information Web Portal and features the 511.org transit page that provides links to the SFMTA and other agencies' schedules. The 511.org transit trip planner also incorporates the SFMTA's scheduled information into its database.

The Contractor supplied MTMS shall support the exchange of data with the Bay Area's regional 511.org traveler information system operated by the Metropolitan Transportation Commission (MTC). Data exchange shall consist of:

- Export of real-time arrival information to 511.org
- Export of MTMS status information to 511.org
- Import of other agencies' real-time arrival information from 511.org
- Import of other agencies' system status information from 511.org.

(XML) document type definitions (DTDs) for the messages exchanged between the transit agency Java Message Service (JMS) client and the 511.org system's JMS server are included in **Appendix Sixteen (16),** for reference only.

The Contractor shall submit a complete technical description of the MTC 511.org real-time interface. **[CDRL 12-3-20 MTC 511.org Interface Description]**

Internal Interfaces

The MTMS system internal interfaces that support the data transfer to configure, operate, and maintain the MTMS shall be provided by the Contractor. A standards-based, or, in the absence of an applicable standard, open and published file transfer shall be used for transferring the data for the following interfaces:

- Trapeze FX shall be the static source of information for routes, schedules, and services for the MTMS. The interface supplied by the Contractor shall be the current version of the Trapeze FX block format interface specification at the time of implementation. In the response to this RFP, the Qualified Proposers shall describe the functions provided through the Qualified Proposer's Trapeze FX interface **[PRL 12-3-17 Trapeze FX Interface].**
- Trapeze Ops (daily dispatch administration module) shall be the source for pre-assigned employee, vehicle, and roster information for the MTMS. The MTMS master employee and vehicle lists shall be kept current and consistent with Trapeze Ops. Same day changes to vehicle and operator assignments made within the Trapeze Ops shall be provided in real-time to the MTMS. Assignment changes which the MTMS captures when vehicle operators log on, or when control center dispatchers and train controllers take corrective action, shall be transferred from the MTMS to the Trapeze Ops system in real-time. The Contractor shall implement this bi-directional interface based upon the SFMTA's Trapeze Ops installation and shall be specified prior to the final design review. The interface supplied and implemented by the Contractor shall be the current version of the Trapeze Ops interface specification at the time of implementation. In the response to this RFP, the Qualified Proposers shall describe the functions provided through the Qualified Proposers' Trapeze Ops interface **[PRL 12-3-18 Trapeze Ops Interface].**
- The SFMTA uses a Geographic Information System (GIS) to maintain stop information. In the response to this RFP, the Qualified Proposers shall describe the provision of a bi-directional interface for Stops Geographic network to/from ArcGIS that updates stop locations in the GIS following changes to accommodate the Automatic Vehicle Location (AVL) functions of the MTMS **[PRL 12-3-19 Stops geographic Network Bi-Directional Interface].**
- Safety related data shall be reported to the SFMTA's safety systems (TransitSafe), and automatically create database records reflecting this data.

The Contractor shall be responsible for all licensing arrangements beyond the scope of the SFMTA's license agreement required for map data used by the MTMS.

3.2.20 Reporting, Archival Data and Support for Queries to Real-Time Data

The SFMTA shall have the rights to access, use, and distribute data to create interfaces to the MTMS, export MTMS data to the SFMTA and third-party licensed systems, publish schedule, real-time and report data, generate reports, and for the other SFMTA purposes to use the MTMS data. The SFMTA will retain all rights to the data consumed or generated by the MTMS.

Real-time operations shall not be affected by the SFMTA reporting and data access by users outside of dispatch, train controller and supervisor operations. Adequate safeguards shall be put in place to ensure that dispatchers and supervisors cannot overload the primary database server with faulty or ill-formulated queries. A secondary database server that takes the processing load off of the primary real time database shall be provided for the purpose of data retrieval for reporting, queries of real time data, data analysis, replication, backup and archival. Enough online data storage shall be provided to keep at least three (3) years of historical data. The historical data shall be accessible by the Contractor provided MTMS applications and tools. Data replication from the primary real-time server to the secondary data storage server shall be an automated process.

Data and database schema to access the data that are more than three years (3) old shall be saved to long term storage media. This archived data shall be deleted from the main or secondary database(s). Data management and restoration tools to copy archived data from long term storage to either a stand-alone database machine or onto the current MTMS database(s) shall be provided. These activities shall be possible by either a graphical user interface or via the command line for automating tasks.

The Contractor shall submit a complete technical description of the database management system, hardware, hardware failure redundancy, and data retrieval methods. **[CDRL 12-3-21 Database Management System Description]**

3.2.21 MTMS Software Tools

Software for the maintenance and troubleshooting of the operation of the MTMS shall be supplied. Such software shall provide access to individual message level activity related to data communication, data transmission, and network health. Access to these software tools shall be controlled by login or other security measures. The MTMS software shall include tools and applications that assist with setup, configuration, reporting, securing, and managing the MTMS applications, data, databases, network, and communication systems. These tools and applications shall be designed for ease of use and provide a high level of control over the operation of the MTMS. MTMS software tools shall assist with:

- Performance monitoring and tuning
- Backup, restoration and recovery
- Anti-virus detection and protection in accordance with the SFMTA guidance
- Modification, extension, and adding of database structures.

3.2.22 Route Data Initialization and Preparation

A transit data management application that facilitates route level data preparation necessary for the proper functioning of the CAD/AVL subsystem shall be supplied. This application shall automate and simplify the data preparation to the maximum extent possible and shall provide tools to help identify data anomalies. The transit data management application shall be capable of importing routes, stops and schedule from the Trapeze FX software scheduling package. The transit data management application shall allow authorized the SFMTA personnel to:

- Edit/Input internal and external annunciation indexes
- Manage digital announcement files
- Edit/Input headsign indexes
- Edit/Input timepoint and stop internal properties such as berth lengths and capture zones
- Merge schedule and geographic data
- Validate Trapeze FX scheduling software data
- Edit/Input Transit Signal Priority (TSP) reference points
- Generate Mobile Data Terminal (MDT) files used by the vehicles
- Define zones related to announcements, arrivals, departures
- Define speed at the interval level
- Complement vehicle configuration properties such as VHM, APC, farebox, TransLink®, dead reckoning calibration and configuration as necessary.

An import utility shall be provided for a seamless data conversion to convert standard GIS formats (MapInfo, AutoCad, ESRI, Integraph, etc.) data into the MTMS base map. Images for background display as well as common map layers shall be imported and made available for display including routes, patterns, stops, roads, interstates, railroads, parks, and waterways and their associated labels.

A field survey tool shall be provided that provides the capability to accurately geo-code the locations of routes, patterns, stops, and timepoints. Geo-code attributes shall include latitude, longitude, compass direction and distance between stops. Entering attributes of collected data points shall be possible while using the survey tool. Location shall be determined by the use of GPS and Differential GPS (DGPS) technologies. Data captured through the field survey tool shall be capable of being merged with the Trapeze FX scheduling data for use within the MTMS. The field survey tool shall be capable of importing routes and stops from the Trapeze FX software scheduling package.

3.2.23 Historical Reporting (Playback)

A historical event display shall playback all pertinent historical messages (including but not limited to messages sent and received by: vehicle mobile data terminal (MDT), operator, dispatch, and garage). The display shall be by a sequence of events on a geographic map. The playback of these events shall include the capability to perform the following functions:

- Allow selection by vehicle(s), vehicle operator(s), route(s), fleet(s), blocks or train(s) or run(s) for specific time frames through a query action window
- Configurable speed of replay for moving forward and backward through events
- Graphic representation of event data on a common MTMS map
- Selectable display of map layers including but not limited to stops, streets, routes, points of interest, and geographical attributes
- Text display of attributes of each vehicle event message including messages related to other onboard systems including transit priority requests, farebox alarms, and automatic passenger counts
- Step forward, step backward and pause the historical display of events
- Zoom, move, center, and fit to window views within the map window
- Distance measuring tool
- Vehicle label by number, schedule and headway adherence, route, vehicle operator, block or train and run
- Vehicle icons that are configurable and display schedule and headway adherence, login status, transfer status, and maintenance status
- Locate vehicles, routes, intersections and objects
- Display route traces
- Date and time messages are logged
- Print the historical display
- Same day playback.

The Contractor shall submit a complete technical description of the historical reporting and playback features provided. **[CDRL 12-3-22 Historical Reporting and Playback Feature Description]**

3.2.24 Reports

A reporting module shall be provided that gives access to a set of standard reports that are provided with the MTMS. The report module shall produce standard FTA (Federal Transit Administration) NTD (National Transit Database), incident, bus, fleet, and employee management reports. The Contractor supplied reports shall be available on demand and be capable of being queried by such attributes as date ranges, time ranges, and any combination of operational parameters such as vehicle IDs, vehicle operator IDs, route numbers, incident report types, etc. Reports shall be formatted in order to be distributed electronically to other SFMTA users and systems. Reports shall be capable of being generated automatically and scheduled for distribution via email on a regular basis. The Contractor shall provide transportation mode specific reports for the SFMTA's operational divisions.

The Contractor provided database(s) shall include a data dictionary and data schema that fully describes and documents the contents, organization, and meaning of all CAD/AVL subsystem database tables, fields, and keys **[CDRL 12-3-23 Data Dictionary, Data Schema].** Access, use, and distribution of the data by authorized SFMTA personnel shall not require additional support, documentation, or licensing from the Contractor. The database dictionary and schema shall provide sufficient information to retrieve any operational or MTMS related CAD/AVL stored data.

The database(s) shall be ODBC compliant to allow connection from third party reporting tools such as Crystal Reports ®.

The Contractor shall provide a reporting tool for ad hoc queries and custom reports. In addition to the Contractor supplied standard reports the Contractor shall work with the SFMTA to provide support for developing (30) customized reports and two hundred (200) hours of report development support once the SFMTA has become familiar with the use of the reporting system of the MTMS.

The suitability of the Contractor's standard reports shall be evaluated for meeting the SFMTA's needs. The reports shall support transportation mode specific reporting on the SFMTA's revenue operating divisions. The report module shall provide detail and summary reports from the following topic areas:

- APC counts, as acquired through the APC system integration
- Incidents
- Route activity
- Schedule and headway adherence
- Transfers
- Voice and data communications activity
- Dispatcher activity
- Vehicle operator activity
- MTMS health

- Vehicle miles and hours
- Passenger miles
- Revenue vehicle miles and hours
- Non-revenue vehicle miles and hours.

3.2.25 Incident Management System

An electronic incident management system shall be provided that gives dispatchers, train controllers, road supervisors and other authorized users involved in transit operations and management the ability to record and document incidents in a central database. The incident management system shall be based on the SFMTA created and managed incident forms. The Contractor shall provide a tool that provides the SFMTA the capability to create and edit incident form layouts through a Contractor provided software tool. This tool shall allow the free placement of form elements such as data fields, labels, drop down boxes, commit and dismiss buttons. Only authorized users such as the SFMTA administrators shall be permitted to make changes to form layouts. Subsequent changes to form layouts shall not inhibit the ability to view forms that were filled out using previous form layouts. The Contractor shall provide an initial set of templates and assist the SFMTA in the development of the SFMTA specific forms, and fifty (50) hours of incident management system template development support once the SFMTA has become familiar with the use of the incident management system of the MTMS.

When an incident report is created, the system shall automatically generate a unique incident identifier. Users such as dispatchers and train controllers shall be able to select the applicable incident form from a forms list. Data elements such as user identification, vehicle number, block or train number, employee number, vehicle location and a timestamp shall automatically be filled into the related from entry fields. Text entry field input shall be checked by an automated spell checker. This spell checker software shall allow the SFMTA administrators to add terms as valid, in order to allow the introduction of transit and SFMTA specific language. After committing and closing an incident form, entries in the form entry fields shall remain permanent. The SFMTA shall be able to re-open an incident and add additional information. This shall automatically be marked with a user identification and timestamp, and included in the form presentation.

Upon receipt of an EA, the relevant incident report shall automatically be created on the assigned dispatch workstation. Repetitive EAs that are being triggered by defects such as defective vehicle EA subsystems shall be effectively filtered.

Incident forms shall have the capability to link to other incident forms, and to attach files such as pictures, video clips and audio files.

After the initial submission of an incident form to the central database, the SFMTA defined distribution lists shall be used to email or text message synopsis information to a SFMTA configured list of recipients. This synopsis shall include a hyperlink to the relevant form data to allow quick discovery of an incident in the central database.

The incident management system shall automatically delete incidents after the expiration of the SFMTA configured retention period. It shall be possible to define indefinite retention, i.e. prevent the deletion of incidents.

The incident management system shall provide a user-friendly, “dashboard” that allow the query of the central database. The dashboard shall display a list of open incidents. User shall be able to sort and filter the list by timestamp, user and other relevant aspects.

An open incident shall not be editable by more than a single user at a time. The SFMTA administrators shall be able to selectively unlock incident reports.

Past and closed incidents shall remain available to users for reference purposes. The Incident Management System shall allow users to find past incidents through context searches, which allow the logical combination of search terms, time range and search by similar terms and wildcard characters. Queries and searches must not impact the system’s responsiveness. Given the expected growth of the central database throughout the lifecycle of the system, system performance shall remain constant and responsive.

As the central database grows with the use of the MTMS, user transaction times and interactions with the incident management system shall remain constant, below 500ms.

Users shall be able to print completed incident forms. Dashboard queries shall also be printable, both interactively and in SFMTA defined batch printing. Batch printing shall occur in the SFMTA configured intervals and times.

As part of their Proposals, Qualified Proposers shall submit a complete description of their existing incident management system. **[PRL 12-3-27 Incident Management System Description]**

The Contractor shall submit a complete technical description of the incident management system including use case gathering requirements, incident management system setup, operation, and customization. **[CDRL 12-3-24 Incident Management System Description]**

3.2.26 Passenger Facing Service Messages

The MTMS shall allow authorized users to create and electronically distribute service messages to the following external systems:

- Underground platform flat screen panel displays, excluding the existing platform LED departure signs.
- Traveler information system web site and surface level stop displays (NextBus system, as described in section 3.21)
- 311 customer service agents
- 511.org regional traveler information system.

The Contractor shall submit a complete technical description of the design and operation of the passenger facing service messaging utilities, features, and operation. **[CDRL 12-3-25 Passenger Facing Service Message System Description]**

3.2.27 Light Rail Vehicle Digital Visual and Announcement System

******* Qualified Proposers are cautioned that installation of Digital Visual and Audio Announcement System on the SFMTA Light Rail Vehicles is a complex endeavor that will not resemble the configuration installed on the rubber-tire fleet. Installation on the SFMTA Light Rail Vehicles will entail a significant electrical and mechanical system integration effort. Special attention should be given to the unique light rail operating environment, high voltage considerations, and material properties.**

The Contractor shall provide an integrated Digital Visual and Audio Announcement System on the SFMTA's fleet of Light Rail Vehicles. Currently a digital voice annunciation system exists on the SFMTA LRVs. This system is available in the Advanced Train Control System's (ATCS) territory underground, when the train operates in ATCS auto mode. As part of this contract, the function of the existing digital voice annunciation system on the LRVs shall be upgraded to include above-ground announcements, as specified in **Appendix Twenty-Three (23)**. LRV wiring diagrams are included for reference in **Appendix Twenty-Nine (29)**. Material and workmanship standards are specified in **Appendix Twenty-Two (22)**.

As part of their Proposals, Qualified Proposers shall submit their approach to implementing the Digital Visual and Audio Announcement System on the SFMTA's fleet of Light Rail Vehicles including considerations for training, fleet cutover, and vehicle installations. **[PRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description and Integration]**

The Contractor shall submit a complete technical description of the design and operation of the Light Rail Vehicle Digital Visual and Announcement System including the following: **[CDRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description]**

- Design drawings showing all modifications to the vehicle
- Vehicle electrical and mechanical interface documentation
- Theory of operation while under ATCS control and otherwise, including failure modes and abnormal conditions
- System installation plan.

3.3 Optional ITS Components

3.3.1 Automatic Passenger Counting System Interface *(option)*

In the response to this RFP, the Qualified Proposers shall include, as an option, an interface to existing Automatic Passenger Counting (APC) equipment. The MTMS shall integrate with the APC onboard subsystem, the data offload of raw passenger counts, the post-processing of APC data, and the APC report module.

Qualified Proposers shall submit a complete description of the Automatic Passenger Counting System Interface. **[PRL 12-3-27 Automatic Passenger Counting System Interface Description (option)]**

The Contractor shall submit a complete description of the Automatic Passenger Counting System Interface. **[CDRL 12-3-27 Automatic Passenger Counting System Interface (option)]**

3.3.2 Track Layout and Turnaround Layer *(option)*

The Contractor shall, as an option, provide a display layer in all relevant displays (e.g. route ladder, map) that shows track layout and tactical trolley route layouts, including switches and turnarounds. Such a layer shall also be provided and displayed on a route-by-route basis. This layer is intended to support dispatchers and train controllers in service recovery decision making. If the relevant data is not available from the SFMTA, the Contractor shall acquire this data, and provide a tool to maintain this data. Changes to track layout and tactical trolley route layouts are rare, and a straightforward ASCII format where changes are made using a text editor could be sufficient. In any case, activation dates for multiple track layout and tactical trolley route layout versions shall be provided.

Qualified Proposers shall submit a complete description of the Track Layout and Turnaround Layer feature. **[PRL 12-3-28 Track Layout and Turnaround Layer Description (option)]**

The Contractor shall submit a complete description of the Track Layout and Turnaround Layer feature. **[CDRL 12-3-28 Track Layout and Turnaround Layer Description (option)]**

3.3.3 Headway Control *(option)*

The Contractor shall, as an option, provide a headway control function. Dispatchers and train controllers shall be able to activate headway control on a route by route basis, and for the SFMTA pre-configured corridors which may be shared by multiple routes. When headway control is activated, the headway between vehicles operating on the affected routes shall be calculated in relation to the leading vehicle (headway adherence value), based on a pre-defined adherence value, or as adjusted by a dispatcher or train controller. The MDT on board of the vehicles shall switch to display the headway adherence value in place of the schedule adherence value. This mode shall be indicated on the MDT.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method for headway control **[PRL 12-3-29 Headway Control (option)].**

The Contractor shall submit a complete description of the Headway Control feature. **[CDRL 12-3-29 Headway Control Description (option)]**

3.3.4 "Crush Load" Detection with Wheelchair Priority Pick-up *(option)*

The Contractor shall, as an option, provide a wheelchair priority pick-up function. This function shall capture situations where wheelchair passengers waiting at a stop or station were passed up by a transit vehicle, due to "crush"-load status. This function shall alert followers on a route or corridor that a wheelchair passenger was passed up. It is expected that vehicle operator assistance through MDT interaction would be required. At a minimum, this function shall display stop and direction information on follower's MDT.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method for wheelchair priority pick-up **[PRL 12-3-30 Wheelchair Priority Pick-Up (option)].**

The Contractor shall submit a complete description of the "Crush Load" detection feature. **[CDRL 12-3-30 Wheelchair Priority Pick-Up (option)]**

3.3.5 Electronic O-1 Sheet Reporting and Vehicle Health Monitoring *(option)*

The Contractor shall, as an option, provide an electronic O-1 sheet reporting function. Upon yard entry of a revenue vehicle, the MTMS shall generate a report as a summary of defects that were captured through Vehicle Health Monitoring and incident management since the last exit of a yard. This report shall be made available to maintenance personnel in the yard, as well as to the SFMTA management upon request. Maintenance personnel (data entry clerk) shall have the opportunity to add information captured from the existing paper O-1 sheets as submitted by vehicle operators upon yard entry. The combined VHM and existing paper O-1 sheet shall be the basis for data entry into the Infor/Spear SHOPS maintenance system by a data entry clerk.

The VHM function shall collect data on revenue-vehicle drive-train performance, MTMS subsystem health warnings, pre-run checklist completion, and discrete alarms in order to identify problems in support of improved maintenance, and reduced vehicle breakdowns. VHM data triggered by operating conditions beyond pre-defined thresholds shall be reported in real-time to the MTMS and stored for reporting purposes. Standard VHM reports and user query tools shall be supplied for easy access to the stored data. As part of their proposals, The Qualified Proposers shall describe the proposed VHM function **[PRL 12-3-31 Vehicle Health Monitoring (VHM) Function (option)]**.

VHM drive-train data and mechanical alarms shall be collected from the installed engine control module provided by the vehicles' manufacturers and/or the J1708 bus, where available. Alarms shall be transmitted over the MTMS data radio network for real-time display to users as defined by the SFMTA's system administrator. The VHM data messages and alarms shall be stored for analysis and interface to the SFMTA's vehicle maintenance system Infor/Spear (SHOPS).

Twelve (12) user defined discrete inputs shall be provided to monitor mechanical alarms. The SFMTA intends to monitor, in addition to wheelchair lift/ramp deployment and the emergency alarm. These discrete inputs shall cover the de-wiring alarm, low oil pressure, hot engine, and low air pressure. The Contractor shall permit the SFMTA to define and connect unused discrete inputs for future requirements.

The Contractor shall submit a complete description of the electronic O-1 Sheet reporting and Vehicle Health Monitoring feature. **[CDRL 12-3-31 Vehicle Health Monitoring (VHM) Function (option)]**

3.3.6 Capture vehicle load using real-time automatic passenger count input *(option)*

The Contractor shall, as an option, provide the capability to compute real-time load on board of revenue vehicles that are equipped with Automatic Passenger Counter (APC). This information shall be made available to dispatchers, train controllers and also be available as a factor for traffic signal priority requests

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of capturing passenger counts in real time, including methods for real time error correction **[PRL 12-3-32 Real Time APC (option)]**.

The Contractor shall submit a complete description how vehicle load is captured using the real time APC interface. **[CDRL 12-3-32 Real-Time APC (option)]**

3.3.7 Predictive Arrival and Departure Information System *(option)*

The Contractor shall, as an option, replace the existing traveler information system with a predictive arrival and departure information system. This replacement excludes the surface shelter variable message signs and their supporting infrastructure, as well as the station platform flat panel displays and station platform LED departure signs. The predictive arrival and departure information system shall drive the surface shelter message signs with dynamic departure information in its existing form, and shall have the capacity to accommodate the ongoing expansion of the existing surface shelter message sign infrastructure.

With this option, the Contractor shall provide an arrival and departure information system designed to raise recognition for transit vehicle arrivals and departures at surface stops and underground stations. A traveler facing web site shall also be provided, It shall conform with the SFMTA's existing accessibility accommodations, including the continuing ability for travelers to effectively use web page readers. At the SFMTA's underground stations, large displays shall show vehicle location on a systematic map of the SFMTA's light rail service network, as is the case with the existing system. Existing displays, their mounting and cabling may be reused.

Information provided shall include scheduled and real-time transit vehicle arrival / departure information, text messages, vehicle location, bay assignments, and other multi-media content. Layout tools shall be provided, The predictive arrival and departure information shall allow the design of supporting alternate purposes other than simply transit scheduling notifications, including multimedia capabilities.

A system administrator user interface shall provide diagnostic information, messaging status, setup, configuration, and messaging capabilities for all locations.

The Contractor shall be responsible for any licensing arrangements and fees required for the map data used by the arrival and departure information system. For FDR, the Contractor shall clearly state location and schedule accuracy and precision that the arrival and departure information system will provide **[CDRL 12-3-33 Arrival and Departure Information System Schedule (option)].** The cutover from the existing

to the replacement traveler information system shall be included in the Contractor's cutover plan. Please refer to **Appendix Thirty-One (31), "SFMTA Surface Stop Shelters with NextBus Displays",** for a reference list of the SFMTA surface stop shelters and NextBus displays.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of implementing the predictive arrival and departure information system **[PRL 12-3-33 Predictive Arrival and Departure System Description (option)]**.

The Contractor shall submit a complete description of the predictive arrival and departure information system. **[CDRL 12-3-34 Predictive Arrival and Departure System Description (option)]**

3.3.8 Predictive Subsystem and Web Services API *(option)*

The Contractor shall, as an option, provide am XML based web interface that makes MTMS information available to the public. This interface shall use TriMet's Web Services API format. The format specification can be found on TriMet's web site (http://developer.trimet.org), for reference, and either build on the existing, or replacement predictive arrival and departure information system, depending on the implementation of that option.

As part of the response to this RFP, the Qualified Proposers shall describe the proposed method of implementing the predictive subsystem and web services API **[PRL 12-3-34 Predictive (option)]**.

The Contractor shall submit a complete description how vehicle load is captured using the real time APC interface. **[CDRL 12-3-35 Real-Time APC (option)]**

3.3.9 Mobile Dispatch Computers *(option)*

The Contractor shall provide, as an option, supervisor mobile workstations that authorized the SFMTA personnel may use to manage the command and control of fleet operations in the field. Thirty (30) mobile computers licensed to run the MTMS software for mobile dispatch capabilities shall be provided. Mounting hardware shall be supplied and installed in the support vehicles used for road supervision. Alternatively, Netbook or tablet style computers may be proposed that are intended to be issued to individual staff rather than being installed in vehicles. The MTMS shall be designed to accommodate up to eighty (80) mobile dispatch computers.

The mobile dispatch computers shall connect to the MTMS via a commercial wireless high speed data network that provides reliable coverage throughout the SFMTA's operating area. The Contractor shall be responsible for contracting, and the recurring cost of the mobile dispatch data communications throughout system implementation, the warranty period as well as any extended maintenance periods.

The mobile dispatch software shall provide similar functionality and response times to that of the dispatcher console including the selective calling of communication systems subscribers such as vehicles, and incident management workflow. The mobile dispatch software shall automatically integrate and coordinate voice and data communications with the central dispatch functions. Terminal emulation shall be acceptable with security enforced through the logon process. Voice communications shall be supported through a portable voice radio interface. Mobile dispatch computers shall be capable of responding to emergency alarms.

In the response to this RFP, the Qualified Proposers shall provide a complete description of their proposed mobile dispatch computer system and describe how the MTMS LAN will be connected to the mobile dispatch computers in a secure fashion **[PRL 12-3-35 Mobile Dispatch Computer Description and Integration (option)].**

The Contractor shall submit a complete description of the mobile dispatch computer system. **[CDRL 12-3-36 Mobile Dispatch Computers (option)]**

3.3.10 Traffic Signal Priority Interface *(option)*

In the response to this RFP, the Qualified Proposers shall include, as an option, an onboard interface to provide Traffic Signal Priority (TSP) requests to intersections on primary San Francisco corridors that the SFMTA operates service as part of the SFgo initiative.

The VLU shall provide a buffered output to send traffic signal priority data to future traffic signal priority equipment installed on board of the fleet. Control of the output shall be configurable via software update, to be based on schedule adherence and real-time passenger load. The following data elements shall be sent to the TSP receiver on a continuing basis, at a minimum rate of (1) update per second:

- Route pattern ID
- Timestamp (in ms from an agreed upon base date
- Distance to intersection, with the SFMTA configured intersection ID. Intersection coordinates, intersection identification and distances shall be the SFMTA configurable on the transit route pattern. It shall be the Contractor's responsibility to develop or contract the development of the necessary accommodations for intersection data to be included in the route pattern data elements of the transit data feed, as received from the Trapeze scheduling system.
- Vehicle speed, with (2) m/s accuracy.

The latency of the data elements sent to the TSP receiver shall not exceed 500ms.

As part of the response to this RFP, the Qualified Proposers shall describe the traffic signal priority interface **[PRL 12-3-36 Traffic Signal Priority Interface (option)]**.

The Contractor shall submit a complete description of the traffic signal priority interface. **[CDRL 12-3-37 Traffic Signal Priority Interface (option)]**

3.3.11 MTMS Development Environment *(option)*

During the life of the system, the SFMTA and/or the Contractor will be required to make periodic updates to software on the CAD/AVL system, radio communications system, and other servers. Ideally, these changes should first be implemented and tested in a separate development environment. In this way, application software updates, operating system updates, service packs, patches, etc. are first tested for functionality and/or compatibility before being introduced into the production MTMS environment.

In the response to this RFP, the Qualified Proposers shall include, as an option, an MTMS development environment. The MTMS development environment shall include the minimum subset of production servers able to demonstrate compatibility between different system components and processes that are running. The MTMS development environment will then be placed into operation during off-peak hours to test the end-to-end effect of any proposed software updates and changes. The “bus-in-the-box” units shall be integrated in the MTMS development environment. It is understood that it is not feasible to duplicate certain parts of the system such as the radio base stations, channel banks, etc. and should not be included in this option.

The Qualified Proposers are encouraged to recommend alternative solutions to a dedicated MTMS development environment that would achieve the SFMTA project goals.

As part of the response to this RFP, the Qualified Proposers shall describe the MTMS Development Environment **[PRL 12-3-37 MTMS Development Environment (option)]**.

The Contractor shall submit a complete description of the MTMS Development Environment. **[CDRL 12-3-38 MTMS Development Environment (option)]**

3.3.12 Yard Management *(option)*

As an option, the Contractor shall provide a yard management system that automatically locates revenue vehicles in the SFMTA yards. The vehicle locations shall be displayed on a yard map, which may be separate or integrated in other displays. The yard management subsystem shall also include automated parking assignment notifications to vehicle operators or maintenance personnel as the vehicle enters and operates in the yard prior to reaching the designated berth. Information about vehicle berth assignments in the yards shall be integrated with the CAD system to allow dispatchers to display the status and location of each vehicle within the yards. The yard map shall display tracks, switches and catenary, as applicable for the individual yards. The location accuracy in the yard shall be sufficient to reliably locate vehicles in relation to the berths, regardless whether vehicle storage is indoors, outdoors, under catenary and any environmental condition found at the SFMTA yards . It is expected that the GPS-based AVL subsystem alone does not provide the required location accuracy. The yard management system shall provide a function to manually correct vehicle locations in cases where the automatic vehicle location and the correct assignment to a storage berth fails. Such failures shall not be greater than 5% with even distribution over all managed berths. The Contractor shall provide all surveys, data acquisition, vehicle and fixed side equipment, installation and testing required for this option. Vehicle born equipment shall be installed as part of the fleet install of non-option components. A separate round of installation shall not be required. The use of battery powered equipment shall not be necessary, and the vehicle's power supplies shall be used.

The yard management system AVL shall be integrated with the AVL of the MTMS such that vehicle tracking provided by the yard management system is available to the users of the MTMS and its dispatch functions.

In the response to this RFP, the Qualified Proposers shall describe the proposed method of automatic vehicle location using the yard management system along with integration with the wide area AVL system **[PRL 12-3-38 Yard Management Automatic Vehicle Location System (option)].**

The Contractor shall submit a complete description of the yard management system. **[CDRL 12-3-39 Yard Management System (option)]**

3.3.13 SFgo CCTV Feeds *(option)*

As an option, the Contractor shall integrate CCTV feeds from outside sources such as SFgo, and provide the capability to distribute these feeds throughout the core network. These feeds shall be available on all dispatch workstations.

In the response to this RFP, the Qualified Proposers shall describe how they would integrate the SFgo CCTV feeds to the dispatch workstations **[PRL 12-3-39 SFgo CCTV Feed (option)].**

The Contractor shall submit a complete description of the SFgo CCTV feeds to the dispatch workstations. **[CDRL 12-3-40 SFgo CCTV Feed (option)]**

3.3.14 Geographically Separated MTMS Hot Standby *(option)*

As an option, the Contractor shall provide a geographically separated hot standby capability for the fixed side MTMS. This capability shall provide an automatic and instantaneous switch between the separated equipment and systems in case the fixed side of the MTMS fails at a location. This event shall be recorded and processed my the NMS, The recovery of the failed site shall not require the shutdown and restart of the MTMS.

In the response to this RFP, the Qualified Proposers shall describe how they would implement a geographically separated MTMS Hot Standby **[PRL 12-3-40 MTMS Hot Standby Feed (option)].**

The Contractor shall submit a complete description of the MTMS Hot Standby. **[CDRL 12-3-41 MTMS Hot Standby (option)]**

3.4 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12-3-1 Software Licensing Terms
- PRL 12-3-2 Major On-board Equipment Components List
- PRL 12-3-3 Approach to Equipping Articulated Vehicles
- PRL 12-3-4 AVL Subsystem Accuracy
- PRL 12-3-5 On-Board Integration Approach
- PRL 12-3-6 Sequencing Routes Converge
- PRL 12-3-7 Detours and Bus Bridges Monitoring
- PRL 12-3-8 Special Revenue Services
- PRL 12-3-9 Route Adherence
- PRL 12-3-10 User Roles and Access Privileges
- PRL 12-3-11 Communications Network
- PRL 12-3 -12 Unit Polling Algorithm
- PRL 12-3-13 Load Analysis
- PRL 12-3-14 Wireless Bulk Data Transfer
- PRL 12-3-5 Data Transfer to Existing Traveler Information System
- PRL 12-3-16 Tracker and ATCS Interface Cutover
- PRL 12-3-17 Trapeze FX Interface
- PRL 12-3-18 Trapeze Ops Interface.
- PRL 12-3 -19 Stops geographic Network Bi-Directional Interface
- PRL 12-3-20 Headway Control.
- PRL 12-3-21 Wheelchair Priority Pick-Up.
- PRL 12-3-22 Vehicle Health Monitoring (VHM) Function.
- PRL 12-3-23 Real time APC
- PRL 12-3-24 Yard Management Automatic Vehicle Location.
- PRL 12-3-25 Mobile Dispatch Computer Integration
- PRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description and Integration

- PRL 12-3-27 Incident Management System Description
- PRL 12-3-27 Automatic Passenger Counting System Interface Description (option)
- PRL 12-3-28 Track Layout and Turnaround Layer Description (option)
- PRL 12-3-29 Headway Control (option)
- PRL 12-3-30 Wheelchair Priority Pick-Up (option)
- PRL 12-3-31 Vehicle Health Monitoring (VHM) Function (option)
- PRL 12-3-32 Real Time APC (option)
- PRL 12-3-33 Predictive Arrival and Departure System Description (option)
- PRL 12-3-34 Predictive (option)
- PRL 12-3-35 Mobile Dispatch Computer Description and Integration (option)
- PRL 12-3-36 Traffic Signal Priority Interface (option)
- PRL 12-3-37 MTMS Development Environment (option)
- PRL 12-3-38 Yard Management Automatic Vehicle Location System (option)
- PRL 12-3-39 SFgo CCTV Feed (option)
- PRL 12-3-40 MTMS Hot Standby Feed (option)
- PRL 12-3-28 Options Description.

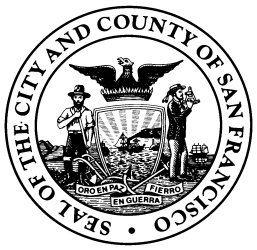
3.5 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-3-1 Pre-inspection Procedure
- CDRL 12-3-2 Emergency Alarm Description of Operation
- CDRL 12-3-3 Wheelchair Ramp or Lift Test Description of Operation
- CDRL 12-3-4 Vehicle Area Network Wireless Router Description]
- CDRL 12-3-5 Computer Aided Dispatch System Description
- CDRL 12-3-6 Service Messaging Description
- CDRL 12-3-7 Textual and Tabular Display Description
- CDRL 12-3-8 Schedule Adherence System Description
- CDRL 12-3-9 Detours and Bus Bridges Monitoring
- CDRL 12-3-10 Route Adherence
- CDRL 12-3-11 Daily Schedules
- CDRL 12-3-12 System Failures Messaging
- CDRL 12-3-13 SFMTA User Groups and Access Privileges
- CDRL 12-3-14 Wide Area Wireless Network System Description
- CDRL 12-3-15 Wireless Bulk Data Transfer System Surveys
- CDRL 12-3-16 On Board Destination and Run Sign Interface Description
- CDRL 12-3-17 TransLink® Interface Description
- CDRL 12-3-18 Farebox Interface Description
- CDRL 12-3-19 NextBus System Interface Description
- CDRL 12-3-20 MTC 511.org Interface Description
- CDRL 12-3-21 Database Management System Description
- CDRL 12-3-22 Historical Reporting and Playback Feature Description
- CDRL 12-3-23 Data Dictionary, Data Schema
- CDRL 12-3-24 Incident Management System Description
- CDRL 12-3-25 Passenger Facing Service Message System Description
- CDRL 12-3-26 Light Rail Vehicle Digital Visual and Announcement System Description
- CDRL12-3-27 Automatic Passenger Counting System Interface (option)

- CDRL 12-3-28 Track Layout and Turnaround Layer Description (option)
- CDRL 12-3-29 Headway Control Description (option)
- CDRL 12-3-30 Wheelchair Priority Pick-Up (option)
- CDRL 12-3-31 Vehicle Health Monitoring (VHM) Function (option)
- CDRL 12-3-32 Real-Time APC (option)
- CDRL 12-3-33 Arrival and Departure Information System Schedule (option)
- CDRL 12-3-34 Predictive Arrival and Departure System Description (option)
- CDRL 12-3-35 Real-Time APC (option)
- CDRL 12-3-36 Mobile Dispatch Computers (option)
- CDRL 12-3-37 Traffic Signal Priority Interface (option)
- CDRL 12-3-38 MTMS Development Environment (option)
- CDRL 12-3-39 Yard Management System (option)
- CDRL 12-3-40 SFgo CCTV Feed (option)
- CDRL 12-3-41 MTMS Hot Standby (option).

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **four**

Network Requirements

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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4.0 Network Requirements

This section describes the current network environment at the SFMTA and City and County of San Francisco (CCSF) sites, the network improvements to be performed by the Contractor, and equipment requirements.

Both the CCSF's Department of Technology and the SFMTA's Information Technology Department operate extensive shared enterprise networks that already connect most of the facilities that will house and support the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS). These networks include microwave backhaul connecting the above ground communications sites, fiber optic networks, leased circuits, and public cellular data services. With the exception of the microwave backhaul, most other elements of the existing physical networks between and within buildings will not be used by the Contractor. Instead a new gigabit fiber optic network, utilizing existing dark fiber, will be constructed and used in conjunction with the City's existing microwave backhaul to the above-ground antenna sites.

What follows is a description of:

- The existing CCSF and the SFMTA network environment
- Desired network topology and architecture
- The CCSF and the SFMTA network improvements required to accommodate the PSVRN and MTMS network connectivity requirements
- Description of equipment to be provided and work to be performed the Contractor.

4.1 Background

A complete description of the functional requirements for the PSVRN and MTMS can be found in **Appendix Twelve (12), Sections Two (2)** and **Three (3)**. This section provides a brief synopsis of the system description for the purposes of putting the network requirements into context.

It is the SFMTA's intent to procure a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by the selected SFMTA staff and CCSF public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users).

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFMTA's Lenox Way Operations Control Center, the SFMTA's One South Van Ness headquarters, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave backhaul, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

As part of this Project, the Lenox Way Operations Control Center theatre will be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to temporarily accommodate rubber-tire vehicle dispatchers.

This RFP assumes a five (5) site communication (RF) system with two (2) additional Operational Control sites. The communication sites, as illustrated in **Appendix Nine (9), "Drawings"**, include:

- Bernal Heights
- Forest Hill
- One Market Plaza
- South Hill
- Twin Peaks.

An additional sixth site at the Clay/Jones building may be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco, CA
- An temporary rubber-tire dispatch center at the SFMTA headquarters at One South Van Ness Avenue, San Francisco, CA to facilitate renovation of the Operations Control Center at 131 Lenox Way, San Francisco, CA
- Vehicle maintenance facilities, emergency operations center, etc.

4.2 Existing Network Description

4.2.1 City and County of San Francisco Department of Technology Networks

Microwave Backhaul

The existing microwave backhaul is illustrated in **Appendix Nine (9), "Drawings"**.

The CCSF interconnects eight (8) different radio sites with three (3) loop microwave networks. Two (2) of these loops are used for the Citywide Emergency Radio System (CERS) with radio sites assigned to either a North or South Loop. The third loop is for the Public Works Emergency Radio System (PERS). The eight (8) radio sites include:

- Fort Miley
- Clay/Jones
- One Market Plaza
- Forest Hill
- San Francisco State University
- Bernal Heights
- Central Radio Station (CRS) Twin Peaks
- South Hill.

The PERS loop has four (4) sites common to CERS. The CERS and PERS microwave networks use loop redundancy for reliability. Each node can select its T-1's to drop from either direction of the loop.

CERS Microwave Loops:

Five (5) sites on the West and North side of the County are considered the CERS North Loop and two (2) sites in the South part of the County are considered the CERS South Loop. Central Radio Station (CRS) at Twin Peaks located in the center of the County serves as the hub for the North and South CERS loops.

All CERS North Loop microwave paths are licensed 18 GHz frequencies and have microwave backhaul capability of 28 T-1's, or DS3. CERS North loop sites include:

- Fort Miley/ VA Hospital
- One Market Plaza
- Forest Hill
- San Francisco State University
- Clay/Jones (repeater only).

All CERS South Loop microwave paths are licensed 18 GHz frequencies and have microwave backhaul capability of 28 T-1's, or DS3. CERS South loop sites include South Hills and Bernal Heights.

PERS Loop Sites:

The majority of the PERS sites are interconnected by a licensed 11 GHz Alcatel microwave system at OC3 (155 Mbps) capacity currently configured for 16 T-1's plus Ethernet traffic. The only exception is CRS Twin Peaks which is connected to Fort Miley via fiber only. PERS loop sites include:

- Fort Miley/ VA Hospital
- Clay/Jones (repeater only)
- One Market Plaza (OMP)
- South Hill/ South City
- CRS Twin Peaks (connected to Fort Miley via FOC only).

The PERS microwave paths are routed in the following manner:

- One Market Plaza (OMP) is connected to Fort Miley via a repeater at Clay/Jones
- One Market Plaza is connected to South Hill
- South Hill is connected to Fort Miley.

Fiber Optic Cable

Fiber Optic Connectivity (FOC) is illustrated in **Appendix Nine (9), "Drawings"**.

With the exception of South Hill, each PERS and CERS site has FOC designed to follow the same routing configuration as the microwave paths to each site. CCSF plans to route FOC to South Hill at a later date. Alcatel switches are installed at each PERS site and are currently configured for 8 T-1's, plus gigabit Ethernet traffic.

The following sites have FOC with some having dual routes and entrances into the buildings:

- Forest Hill – single route
- One Market Plaza – dual route and entrances
- CRS Twin Peaks – single route
- Bernal Heights – single route
- 131 Lenox Way – single route, with a second route planned using City fiber from the West Portal Station
- One South Van Ness – dual route and entrances.

The following the SFMTA vehicle maintenance and storage sites currently have dark fiber available:

- Potrero Division (2500 Mariposa Street)
- Muni Metro East (601 25th Street)
- Presidio Division (949 Presidio Avenue)
- Green Division (425 Geneva Avenue).

The CCSF plans to provide dark fiber connectivity to the following SFMTA vehicle maintenance and storage sites in the near future:

- Woods Division (1001 22nd Street)
- Islais Creek (1301 Cesar Chavez)
- Marin Division (1399 Marin Street)
- Flynn Division (1940 Harrison Street).
- Cable Car Division (1201 Mason Street)
- Pennsylvania (700 Pennsylvania Avenue)

No FOC exists to the Kirkland Division (151 Beach Street) and the SFMTA plans to cease operations at this facility after Islais Creek opens.

The SFMTA is currently designing the Central Subway Project, a three station 1.7 mile rail line 4th and King Streets to Chinatown. The Central Subway will intersect the Market Street Subway at Powell Street where a network connection is envisioned in the future.

4.2.2 SFMTA Existing Networks

Light Rail subway dark fiber currently terminates at 131 Lenox Way. CCSF fiber terminates at the West Portal Station, to be extended to 131 Lenox Way by the City.

The SFMTA operates extensive in-building networks in each of the facilities. With the exception of One South Van Ness Avenue, the SFMTA vehicle maintenance divisions and 131 Lenox Way already have existing in-building networks whose state or condition is unknown. These existing networks are likely to be unusable for PSVRN and MTMS network connectivity will require the Contractor to make improvements. The existing physical network in One South Van Ness Avenue is likely usable and can be used to connect from the fiber distribution panel on the third floor to the interim rubber tire dispatch center intended for the eight floor.

4.3 Network Topology Preliminary Design

The network topology to support the PSVRN and MTMS is shown in **Appendix Nine (9), "Drawings"**. Existing and planned SFMTA Site connectivity along with type is shown in Exhibit 4.3-1.

The Contractor shall submit detailed wide-area network site connection diagrams including patch panel connections and all intermediate connections throughout the City **[CDRL 12-4-1 Wide Area Network Diagrams]**.

As part of their Proposal, Qualified Proposers shall submit a description of the intended network topology **[PRL 12-4-1 Network Topology]**.

Exhibit 4.3-1: SFMTA Site Connectivity

	Connectivity	
Site	**Microwave**	**Fiber**
Above Ground Radio Communications		
One Market Plaza	**X**	**X**
CRS Twin Peaks	**X**	**X**
Forest Hill	**X**	**X**
Bernal Heights	**X**	**X**
South Hill	**X**	**planned**
Clay/Jones		**X**
Control Centers		
131 Lenox Way		**X**
One South Van Ness Ave.		**X**
Maintenance Divisions		
Potrero Division		**X**
Muni Metro East		**X**
Presidio Division		**X**
Green Division		**X**
Woods Division		**X**
Islais Creek		**planned**
Flynn Division		**planned**
Cable Car Division		**planned**

4.4 Network Architecture Preliminary Design

The Network Architecture preliminary design is illustrated in **Appendix Nine (9), "Drawings"**. The design includes the following elements:

- Radio communications prime site, and primary network core switch at Bernal Heights
- Backup network core switch at CRS Twin Peaks
- Primary Operations Control Center and Centralized MTMS servers at 131 Lenox Way
- Interim rubber-tire dispatch center at One South Van Ness Avenue
- Above-ground communications sites:
  - Bernal Heights
  - Forest Hill
  - One Market Plaza
  - CRS Twin Peaks
  - South Hill
  - Clay/Jones (stand-alone, remote monitoring via fiber only)
- Below-ground communications sites (remote monitoring only)
- MTMS data and voice radio communications at multiple SFMTA vehicle maintenance facilities:
  - Potrero Division
  - Muni Metro East
  - Presidio Division
  - Green Division
  - Woods Division
  - Flynn Division
  - Islais Creek
  - Cable Car Division
- Other base ITS components connections
- Internet connection to MTC's 511.org
- Connection to the SFMTA's Trapeze data
- Public cellular data connections to cable cars.

The Contractor shall submit detailed local-area network diagrams including patch panel connections and all intermediate connections throughout each facility **[CDRL 12-4-2 Local Area Network Diagrams].**

4.5 Network Security

4.5.1 General Network Security Considerations

In order to minimize the failure of any one security device, the Contractor shall employ a multi-layer strategy involving two (or more) different overlapping security mechanisms, including the use of firewalls, demilitarization zones (DMZ), intrusion detection, and security policy enforcement. The Contractor's network security design shall follow guidelines established in NIST-800-82 Guide to Industrial Control System Security, considering such threats as:

- Backdoors and holes in the network perimeter
- Vulnerabilities in common protocols
- Attacks on field devices
- Database attacks
- Communications hijacking and 'man-in-the-middle' attacks.

There shall be no direct connection between either the SFMTA, CCSF, or PSVRN/MTMS networks, except through one of the above methods such as firewall and/or DMZ.

The Contractor shall submit a Network System Security Plan providing an overview of the security requirements along with describing the specific security controls that will be provided to meet those requirements **[CDRL 12-4-3 Network System Security Plan].** The security controls that fall within the NIST SP 800-53 Planning (PL) family shall provide the basis for developing the security plan. These controls also address maintenance issues for periodically updating a security plan.

Throughout this process, the Contractor shall work with the SFMTA and CCSF information technology staff to implement the network and all aspects of network security functions and features.

As part of their proposals, Qualified Proposers shall submit a description of network security requirements and how those requirements will be met **[PRL 12-4-2 Network Security Description].**

4.5.2 Network Configuration Management

In conjunction with the Network Management System specified in Section 4.6, the Contractor shall provide a utility for the SFMTA and CCSF staff to remotely monitor and manage the configuration of the PSVRN/MTMS network. The software utility shall include the ability to remotely monitor and audit changes to network configuration(s), along with providing the ability to remotely configure, secure, and update any devices on the PSVRN/MTMS network. The network configuration management utility shall be capable of providing regular reports and alert notifications (via email or SMS) of all network changes, both authorized and unauthorized.

4.5.3 Network Intrusion Detection System

In an attempt to identify an intruder breaking into or attempting to break into the PSVRN/MTMS network, the Contractor shall provide an Intrusion Detection Systems (IDS) to monitor events on the network, including, but limited to traffic patterns, log entries, and file accesses. The IDS shall provide regular reports and alert notifications for unusual activity such as new open ports, unusual traffic patterns, or changes to critical operating system files. The IDS shall include both host-based and network-based components and be capable of being configured to filter false alarms related to normal network activity.

4.6 Network Management

4.6.1 General Requirements

All subsystems shall be under control of a single network management scheme. The scope of the single network management scheme includes the five basic elements of network management:

- Configuration management
- Fault management
- Security management
- Performance management
- Accounting management.

Network Management System (NMS) general requirements include:

- Use of open system standards - The NMS shall be developed using Open Systems Standards to gain maximum flexibility and scalability of the NMS. This functionality will also allow for easier enhancements from other software/hardware providers.
- Use of client/server architecture - The Contractor shall provide for a true multi-user, multitasking system, following a client/server architecture and be capable of supporting 10 MBps and 100 MBps LAN and Gigabit Ethernet connectivity. The operating system will allow for compatibility across many hardware platforms. The hardware architecture shall provide multiple levels of computing power based on the size of the network. Qualified Proposers shall define the operating system programming language and platforms that will be used to develop the offered NMS.
- Provide expandable processing power
- Enable expandable number of users (Contractor to specify number of simultaneous users)
- Be user friendly - The NMS shall be developed in a logical manner so that the user can understand the conceptual layout of the application software as related to the overall network. The design shall allow for on-screen help menus and user-understood prompts that provide direction and assistance through the learning process. These learning tools shall be able to be placed in the background after user efficiency is achieved. Training and user manuals shall contain the same information provided on help screens and prompts.
- Employ use of modular software
- Use a powerful operating system

- Use a relational database - The NMS shall be supplied with an industry-standard relational database management system such as SQL Server or Oracle. In the response to this RFP, the Qualified Proposers shall indicate manufacturer and version of the relational database as part of their response to this RFP. Additional relational database requirements include:
  - All database entries shall be user restricted and password protected, and all transactions shall be logged and tagged by user names.
  - Redundancy and fault tolerant design
  - Security and user partitioning (Contractor to specify number and capabilities of partitions)
  - Capable of interfacing with MapInfo, AutoCAD, ARCINFO, ESRI products, and Microsoft Office
  - Capable of interfacing with other Contractor NMS'.
  - The database and software must be able to store objects and their relationships
  - The NMS shall have the capability to use other databases across the network
  - Software tools shall be provided to update both database and the graphical network depiction as the network expands or is being modified.
  - All user terminal positions shall have access to printers to output activity reports or other output produced by the NMS.

The NMS shall incorporate a graphical user interface (GUI) system manager/information management system to set selected parameters and allow the supervisory personnel to control and analyze NMS operation.

The Contractor shall submit a complete description of the Network Management System, including all subordinate network management systems and interfaces for individual subsystems **[CDRL 12-4-4 Network Management System Description].**

4.6.2 Alerts and Notifications

A programmable, audible alert for critical alarms shall be provided at the Operations Control Center. Critical failures should be automatically displayed to alert appropriate radio maintenance personnel. If positive acknowledgement is not received within 30 minutes, the NMS shall contact maintenance personnel by alternate means (i.e. telephone, pager, e-mail).

The NMS shall provide alarm conditions down to board level failures of all network elements.

All reported network problems shall be entered into NMS trouble tracking system, and problem history records shall be stored for each user.

The NMS shall also incorporate a feature that graphically illustrates network trends and statistics.

4.6.3 Remote Access

The SFMTA requires the capability of monitoring the integrated radio network using a VPN connection from remote locations via the Internet. The SFMTA's system managers, technicians, and other types of personnel shall be able to perform monitoring and obtain access to the network through such remote connections.

These remote monitoring and control functions shall comprehensively cover all monitoring and control functions, such that system management can be conducted in case government orders in response to pandemics, earthquakes or other events are in place.

The NMS shall be capable of supporting remote access using a System Manager user terminal without degradation of terminal performance. A remote user terminal shall be capable of performing/accessing all the same functions/information that a local terminal can.

The speed at which the remote terminal operates shall be equivalent to that of a local terminal and the accessing of information shall not be noticeably different in physical appearance or access time.

A minimum of two remote terminals shall be provided. The Contractor shall provide the necessary connectivity to remote terminals.

The remote terminals should enable a user to have access to required NMS manager capabilities. These capabilities shall include:

- NMS configuration—shall be able to control all of the programmable features of the trunking controller and radio infrastructure
- Subscriber management—shall allow an operator to view, set, or modify the talk group IDs, and the unique ID profiles.

4.6.4 Security and User Partitioning

The NMS shall support multiple levels of access that are protected in a manner that will allow users to control, monitor, and use software applications that have been partitioned for specific use by the end-user.

In the response to this RFP, the Qualified Proposers shall provide a detailed description of this capability by defining the levels of partitioning and security, total number of end-users, the total number of simultaneous users with independent views, and the method used to achieve this requirement.

End-users will be at different locations, such as dispatch centers, offices, maintenance facilities, and other remote sites. Therefore, this feature shall be provided to remote locations to allow restricted access to the overall radio network.

4.6.5 Redundancy and Fault Tolerant Design

The NMS shall ensure uninterrupted network monitoring (redundancy) by supporting multiple redundant network management stations through remote background processing communications. This enables each network management station to operate as a full backup in the event of equipment failure.

The NMS shall be supplied with a backup server and associated equipment to support a failed main server or any component of the server that will cause a failure.

In the response to this RFP, the Qualified Proposers shall describe this backup configuration offering and any fault tolerant equipment offered as a response to the specifications.

4.6.6 Monitoring and Control of Other Components

The NMS shall be capable of controlling each and every system that is part of the integrated radio system. These systems shall include, but not be limited to, the items listed below. A list of elements and alarms is provided as a starting point in the development of the NMS.

- Power supply systems
- Tower lights
- Shelter
- Emergency generator
- Automatic transfer switch
- HVAC units
- Door
- Fire and smoke monitors
- Radio communications system (i.e., power, VSWR, diagnostics, and reflected power)
- Temperature.

Each of these items and components shall be monitored and controlled for specific management and diagnostic reasons.

The monitoring and controlling operations shall be performed by network elements, RTUs, and SCADA elements, as required.

4.7 Statement of Work

4.7.1 Work Done By Others

This section describes work to be performed by others in preparation for the Contractor's installation of the MTMS and PSVRN.

Although it is the SFMTA's intent to have this work completed in advance of the Contractor's need for network connectivity, the SFMTA reserves the right to issue a contract change notice to the Contractor to perform any necessary remaining work. In such case, the SFMTA will make a best effort to notify and negotiate this work with the Contractor well in advance of the need for network connectivity.

Microwave Backhaul Improvements

The SFMTA and CCSF believe there is sufficient capacity available on the PERS Microwave loop and that only the One Market Plaza to South Hill path would be used for the PSVRN and MTMS with no improvements required.

The remaining PSVRN/MTMS sites (see **Appendix Nine (9), "Drawings"**) shall be connected as follows with indicated capacity:

- South Hill to Bernal Heights via CERS South Loop – Licensed 18 GHz Harris equipment with 45 Mbps capacity, with approximately 50% available capacity.
- Bernal Heights to Twin Peaks via CERS South Loop – Licensed 18 GHz Harris Equipment with 45 Mbps capacity, with approximately 50% available capacity.
- Twin Peaks to South Hill via CERS South Loop – Licensed 18 GHz Harris equipment with 45 Mbps capacity, with approximately 50% available capacity
- Twin Peaks to Forest Hills and One Market Plaza via CERS North Loop – Licensed 18 GHz Harris equipment with 45 Mbps capacity, with little or no available capacity

As part of their Proposal, Qualified Proposers shall indicate their capacity their backhaul requirements for the combined PSVRN and MTMS, with spare capacity for future growth **[PRL 12-4-3 Backhaul Requirements for Combined PSVRN and MTMS].**

Dark Fiber

With the exception of those sites listed above, the SFMTA believes there is existing or planned dark fiber capacity to each site housing the PSVRN and MTMS equipment. The SFMTA intends to provide backup FOC to 131 Lenox Way in the near future.

4.7.2 Work to Be Performed By The Contractor

Network Design

The Contractor shall consider the network architecture and topology described above to design a network to accommodate all needs of the PSVRN and MTMS. The design shall consider existing CCSF and the SFMTA provided microwave backhaul, FOC, and in-building cabling. The Contractor's design shall include specification, selection, and configuration of all necessary core and edge equipment to accommodate the needs of the PSVRN and MTMS.

The network shall be designed to provide, with improvements, sufficient capacity for future growth beyond existing projected air-time measurements listed in **Appendix Nineteen (19)** and fleet growth.

The network design shall include hardware and software to provide all security features listed above.

The Contractor's design shall consider all inherent latencies and delays to be anticipated traversing the CCSF and the SFMTA microwave and dark fiber infrastructure and include all equipment with flexibility to minimize the effects of such latency in implementing the PSVRN and MTMS.

Network Interface Criteria

The Contractor shall identify all electrical, mechanical, and physical interfaces associated with the network equipment installation and as shown on the Contract Drawings. These shall include, but not limited to, the following network interfaces:

- Between the various systems, subsystems, equipment, and materials included in these documents.
- Between the systems, subsystem, equipment, and materials included in these documents and existing systems, subsystems, and equipment.

The Contractor-provided system, subsystem, equipment, and materials shall be designed to have the characteristics required to ensure that electrical, mechanical, and physical interfaces achieve the specified grade of service and performance levels on a non-interfering basis with existing system and equipment functions.

The Contractor shall be fully responsible for the correct interfacing of the systems, facilities, and equipment that are provided under this Contract with the existing SFMTA and CCSF systems, subsystem, equipment, and facilities. If any incompatibility is discovered, the Contractor shall correct the incompatibility by modifying the additional required equipment and material and correcting the manuals and drawings

at no additional cost to the SFMTA. Unless otherwise specified, modifications to the equipment of existing systems, subsystems, and facilities will not be permitted.

On-site technical assistance from the Contractor shall be provided for system installation and testing when interfacing with the SFMTA or City and County of San Francisco provided network equipment.

Equipment Installation and Configuration

The Contractor shall be responsible for installation, configuration, testing of all network core and edge equipment from the connection to the SFMTA and CCSF provided demarcation points at each location throughout the system.

The Contractor shall immediately notify the SFMTA of any problems or deficiencies with network connectivity between any sites. The SFMTA and/or CCSF staff will make immediate attempt to correct the situation, or at its discretion, request that the Contractor make necessary repairs to reimbursed on a time and material basis.

Mitigation of CERS North Loop Capacity Constraints

As noted above, the CERS North Loop as insufficient spare bandwidth capacity to support the added demands of MTMS and PSVRN network traffic. To mitigate this deficiency, the Contractor shall install a licensed DS3 point-to-point microwave connection between CRS Twin Peaks and Forest Hill to support MTMS and PSVRN network traffic.

The Contractor shall submit a complete description including features, installation details, and interface description for the point-to-point microwave connection between CRS Twin Peaks and Forest Hill **[CDRL 12-4-5 Point-to-Point Microwave Description Between CRS Twin Peaks and Forest Hill].**

4.8 Network Equipment Requirements

4.8.1 Equipment Availability and Serviceability

All network equipment shall be commercially available through multiple sellers or distributors. The manufacturers of such equipment shall have implemented a standard Quality Assurance program such as ISO 9001 certification.

All network equipment shall have a minimum of five (5) years warranty from the manufacturer.

4.8.2 Equipment Management

Management protocols supported shall include SNMP, RMON, and Telnet. Management Information Bases shall be available from the equipment vendor(s) to be used by the Contractor in the implementation of the Network Management System. The switches shall have embedded web-based management software with the ability to manage up to 16 switches at once.

4.8.3 Equipment Features

The network equipment shall be rack-mountable.

All switches shall auto-detect full and half-duplex operation on all ports.

All switches shall support VLAN (IEEE 802.1Q) and Spanning Tree Algorithm protocols (IEEE 802.1d).

4.8.4 Design Submittals

The Contractor's Network Design Document **[CDRL 12-4-6 Network Design Document]** shall include, as a minimum:

- A network diagram of the system including all interfaces and devices
- Specification sheets for all proposed network components
- IP addressing scheme that is consistent with the SFMTA and CCSF IT Department assignment conventions
- A network list for all devices, showing proposed network addresses, subnets, gateways, mask assignments and terminal address of each device
- Equipment final layout diagrams showing equipment in each rack and/or cabinet
- Bills of materials for all network equipment and accessories.

4.9 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

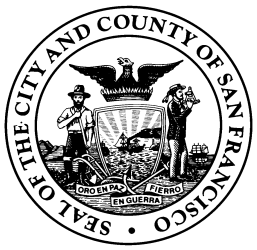
- PRL 12-4-2 Network Topology
- PRL 12-4-2 Network Security Description
- PRL 12-4-3 Backhaul Requirements for Combined PSVRN and MTMS.

4.10 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-4-1 Wide Area Network Diagrams
- CDRL 12-4-2 Local Area Network Diagrams
- CDRL 12-4-3 Network System Security Plan
- CDRL 12-4-4 Network Management System Description
- CDRL 12-4-5 Point-to-Point Microwave Description Between CRS Twin Peaks and Forest Hill
- CDRL 12-4-6 Network Design Document.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **five**

System Installation and Cutover

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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5.0 System Installation and Cutover

This system describes the work to be performed by the Contractor to install and cutover the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS). Detailed requirements for the system test program are described in **Appendix Twelve (12), Section Seven (7).**

A complete description of the functional requirements for the PSVRN and MTMS can be found in **Appendix Twelve (12), Sections Two (2) and Three (3)**. What follows is a brief synopsis of the system description for the purposes of putting the site installation requirements into context.

It is the SFMTA's intent to procure, via a design-build project, a fully integrated system that includes:

- The MTMS including, but not limited to, digital trunked voice and data communications for all transit operations, computer aided dispatch, automatic vehicle location, integrated incident management/reporting, single-point logon for revenue vehicles, and on-board ADA compliant traveler information
- An interoperable Project-25 compliant PSVRN for joint use by selected the SFMTA staff and City and County of San Francisco (CCSF) public works employees including the Department of Public Works, Port of San Francisco, and Department of Building Inspection (with no public safety users).

Radio communications equipment, computer servers, network equipment, and all necessary software will be installed at above ground radio communications sites, the SFMTA's underground rail tunnels and platforms, the SFMTA's Lenox Way Operations Control Center, the SFMTA's One South Van Ness headquarters, vehicle maintenance facilities, and other CCSF sites. These sites will be interconnected using a combination of the CCSF's existing microwave communications system, existing fiber optic cable, leased communications circuits, and the public cellular data networks.

As part of this Design/Build project, the Lenox Way Operations Control Center theatre will be refurbished to accommodate the new dispatch consoles. In order to facilitate the renovation of the Lenox Way Operations Control Center, the existing Line Management Center at the SFMTA's One South Van Ness headquarters will be modified to accommodate rubber-tire vehicle dispatchers.

This RFP assumes a (5) five site communication (RF) system with (2) two additional central control sites. The communication sites, as illustrated in **Appendix Nine (9), "Drawings"**, include:

- Bernal Heights
- Forest Hill
- One Market Plaza
- South Hill
- Twin Peaks.

An additional site at the Clay/Jones building will likely be retained to house a stand-alone 800 MHz repeater for cable car machinery maintenance operations.

Control sites include:

- Operations Control Center at 131 Lenox Way, San Francisco
- An interim rubber-tire dispatch center at the SFMTA headquarters at One South Van Ness Avenue, San Francisco, to facilitate renovation of the Operations Control Center at 131 Lenox Way
- Vehicle maintenance facilities, emergency operations center, etc.

5.1 System Installation General Requirements

On a site-by-site basis, the Contractor shall perform work required to prepare sites for the installation of all MTMS and PSVRN system components.

The Contractor shall submit all designs, specifications, drawings, and plans to the SFMTA for acceptance before proceeding with any work. The final drawings shall provide adequate direction to the construction forces on the execution of the site specific Infrastructure work. The drawings shall be a complete representation of the work to be done. The drawings shall permit the SFMTA to have a clear understanding of all of the work to be accomplished. The drawings shall permit the SFMTA to review the planned work and to facilitate approval.

The Contractor shall perform all necessary site modifications, including material and labor. The Contractor shall also perform all modifications that are deemed temporary in order to facilitate installation and testing of the system components.

If the Contractor fails to mention or identify necessary improvements or neglects to specify all facility requirements, the Contractor shall remedy the problems that arise at its own expense.

Proposers, as part of their proposals, shall describe in detail any environment requirements which include but are not limited to, all grounding, electrical power specifications, humidity, temperature requirements for facilities and vehicles that will house the equipment **[PRL 12-5-1 Environment Requirements]**. Proposers, as part of their proposals, shall also describe the required installation space, bays and the expected installation duration as impact to the SFMTA (down time) **[PRL 12-5-2 Required Equipment Space]**. Proposals shall address the following areas of work:

- Vehicles, for each individual vehicle type
- Backhaul infrastructure
- Base station sites
- Controller and server sites
- Underground structures, including cable car below grade structures, if applicable
- Control Center
- Interim Line Management Center
- Divisions (yards) including but not limited to wireless LAN coverage areas, dispatch positions and Meet-and-Greet.

5.1.1 Summary of Site Work

The Contractor shall be responsible for gathering all data needed and shall conduct site surveys at each site and for all vehicles to determine its present condition and suitability for use.

A site summary follows:

Location	Site Description	Work Location
One Market Plaza	Remote Radio Site	A new room in existing building
Bernal Heights	Remote Radio Site	A shared room in existing building
Twin Peaks	Remote Radio Site	A shared room in existing building
Forest Hill	Remote Radio Site	A shared room in existing shelter and interim shelter
South Hill	Remote Radio Site	A new shelter on an existing site
Lenox Way	Control Center	Staged renovation of an existing control room
One South Van Ness	Temporary Control Center	A shared room in existing building
Underground tunnels, platforms, and passageways	Remote Radio Site	New Radio System in approximately7 miles of tunnels
Clay and Jones	Remote Radio Site	A shared room in existing building

5.1.2 Documentation Requirements

The final design documents shall include specifications for the following products, as minimum:

- Lighting (for Lenox Way)
- Transformers (120 Volts and up)
- Towers or tower components
- Shelters
- Generators
- Automatic Transfer Switches
- UPSs (above 6 KW)
- Battery Chargers above 6 KW
- Stationary Batteries
- Electrical Distribution Panels
- Pre-Action Gas based Fire Suppression Systems
- FM200 Fire Suppression Systems
- Fire detection and remote alarm systems
- Air Handlers using externally provided chilled water
- And other equipment and systems that the SFMTA deems appropriate.

The services provided by the Contractor shall include but shall not be limited to the following:

- *Product Description*: The Contractor shall provide a complete description of the product or system to be delivered. This description shall be associated with the purchase process of the product or system. The description shall be that of a product that meets all of the requirements of the associated specification. This description shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.
- *Shop Drawings:* The Contractor shall provide a complete shop drawings of the product or system to be delivered. This shop drawings shall be associated with the purchase process of the product or system. The shop drawings shall be compatible with the Contractor's produced design drawings. The shop drawings shall provide a complete description of the size, shape, configuration, interface, operation, capacity of the product or system. This shop drawing package shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.

- *Shop Test Reports:* The Contractor shall provide complete test reports on the product or system as required by the specification. This shop tests shall be referred to in the purchase process of the product or system. The shop tests shall demonstrate that the product or system meets the requirements of the associated specification. These test results shall be provided to the SFMTA prior to delivery of the product or system to the Contractor.
- *Shop Visits:* The Contractor shall permit visits to the factory, by the SFMTA, during the time when the product or system that was sold for the SFMTA use is being: manufactured, assembled or tested. The factory visits shall be coordinated by the Contractor. The visit details of time, place, etc. shall be at the mutual agreement of all parties. The Contractor shall inform the SFMTA in a timely manner when manufacture, assembly or testing is expected to occur.
- *Shop Test Witnessed:* In specific cases the Contractor shall permit the SFMTA (or a representative) to be present for factory tests of the product or system being supplied. The arrangements for attendance at the tests shall be made by the Contractor. The timing and procedure for the test shall be the result of mutual agreement between all parties. The SFMTA shall be notified of the test schedule well in advance.

The following documentation is required for the specifications listed below. This list of documentation requirements is not to be taken as complete or prescriptive. The requirements in the final specifications shall conform the needs of the evolving design.

- **Lighting (for Lenox Way) Product Description Required:**
  - Shop Drawings Required: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Transformers (120 Volts and up)**
  - Shop Drawings Required: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Towers or tower components**
  - Shop Drawings Required: Yes
  - Structural Analysis: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No

- **Shelters (permanent)**
  - Shop Drawings Required: Yes
  - Permit Drawings: Yes
  - Structural Analysis: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: Yes
  - Shop Test Witnessed: No
- **Shelters (interim)**
  - Shop Drawings Required: Yes
  - Permit Drawings: Yes
  - Structural Analysis: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Generators**
  - Shop Drawings Required: Yes
  - Permit Application Documents: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: Yes
- **Automatic Transfer Switches**
  - Shop Drawings Required: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **UPSs (above 6 KW)**
  - Shop Drawings Required: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No

- **Battery Chargers above 6 KW**
  - Shop Drawings Required: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Stationary Batteries**
  - Shop Drawings Required: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Electrical Distribution Panels**
  - Shop Drawings Required: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Fire Alarm Systems**
  - Shop Drawings Required: Yes
  - Permit Application Documents: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Pre-Action Gas based Fire Suppression Systems**
  - Shop Drawings Required: Yes
  - Permit Application Documents: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: Yes

- **FM200 Fire Suppression Systems**
  - Shop Drawings Required: Yes
  - Permit Application Documents: Yes
  - Shop Test Reports: No
  - Shop Visits Required: No
  - Shop Test Witnessed: No
- **Air Handlers using externally provided chilled water**
  - Shop Drawings Required: Yes
  - Shop Test Reports: Yes
  - Shop Visits Required: No
  - Shop Test Witnessed: No

5.2 Structural Design Requirements

As part of the Contractor's structural design, the contractor shall be required to:

- Verify the structural adequacy of existing antenna towers, their foundations and/or support systems for the new radio communications system installation
- Design modifications to the existing structures as required.
- Design anchorage and support for lateral loads of radio antennae, equipment, brackets, and other components.
- Modify existing structures to accommodate the installation of ancillary components such as equipment racks, air conditioning and duct systems, electrical raceways etc.

Structural design shall conform to 2007 California Building Code (CBC) and 2007 San Francisco Building Code, and shall be based on the specific design criteria cited below.

5.2.1 Seismic Design Criteria

Seismic Design Criteria are listed below:

- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and Other Structures" including supplement No. 1.
- ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1613 and Chapter 35.

Applicable portions in ASCE/SEI 7-05 shall include but are not limited to the following chapters:

- Chapter 2 - Combination of loads
- Chapter 3 - Dead loads, soil loads, and hydrostatic pressure
- Chapter 11 - Seismic design criteria
- Chapter 13 - Seismic design requirements for nonstructural components.

In addition, the load combinations in CBC section 1605 shall also apply.

The seismic demand on the equipment and other nonstructural components that are permanently attached to the structures and for their supports and attachments shall be based on ASCE/SEI 7-05 equation 13.3-1 for calculating the seismic design force (Fp).The component importance factor (Ip) shall be taken as 1.5; the radio antennae and equipment are required to function after an earthquake (ASCE/SEI 7-05 13.1.3).

Equipment racks and cabinets shall be positively anchored to floor at the base, and be supported laterally with opposite pair of braces in no less than two directions.

5.2.2 Wind Design Criteria

Wind design criteria are listed below:

- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and Other Structures" including supplement No. 1.
- ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1609 and Chapter 35.
- American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard reference number 7-05 titled "Minimum Design Loads for Buildings and Other Structures" including supplement No. 1. ASCE/SEI 7-05 is referenced in the 2007 California Building Code (CBC) section 1609 and Chapter 35.
    - Chapter 2 - Combination of loads
    - Chapter 3 - Dead loads, soil loads, and hydrostatic pressure
    - Chapter 4 - Live loads
    - Chapter 6 - Wind loads.

In addition, the load combinations in CBC section 1605 shall also apply. The wind loading on the exterior equipment and other components (e.g. antennae connections) shall be based on ASCE/SEI 7-05 chapter 6. The following methods can be used:

- Method 1 - Simplified procedure for components and cladding: Equation 6-2 (section 6.4.2.2) if the conditions in section 6.4.1.2 are met.
- Method 2 - Analytical procedure for components and cladding
    - Equation 6-22 (section 6.5.12.4.1) for low-rise buildings/structures with height less than or equal to 60'
    - Equation 6-23 (section 6.5.12.4.2) for buildings/structures with height greater than 60'
- The conditions in section 6.5.1 of CBC shall be met.

The following methods can be used for the wind loading on the supporting elements, defined as the main wind-force resisting system (MWFRS) in section 6.2:

- Method 1 - Simplified procedure for MWFRS: Equation 6-1 (section 6.4.2.1) if the conditions in section 6.4.1.1 are met.
- Method 2 - Analytical procedure for MWFRS

  i. Equation 6-17 (section 6.5.12.2.1) for rigid buildings/structures with height less than or equal to 60'

  ii. Equation 6-19 (section 6.5.12.2.3) for flexible buildings/structures

  iii. As an alternative to equation 6-17, equation 6-18 (section 6.5.12.2.2) for low-rise buildings/structures with height less than or equal to 60'

The wind design criteria for EIA/TIA 222 Rev. G shall also apply.

5.2.3 Foundation Design Criteria

Foundation criteria are listed below:

i. Foundations shall be designed in accordance with the recommendations in the geotechnical report and/or Chapter 18 (soils and foundation) of the 2007 California Building Code.

ii. The SFMTA will provide, upon request, geotechnical reports on South Hill and Forest Hill for information on site conditions, foundation recommendations and other requirements.

iii. Foundation plans and details shall be reviewed by the geotechnical engineer of record to verify conformance with the recommendations in the geotechnical report. The geotechnical engineer of record shall issue a letter of conformance subsequent to the review of the plans; any recommendations shall be incorporated into the plans.

Foundation design criteria, based on available geotechnical reports, for the South Hill and Forest Hill sites are summarized in the table below.

Foundation Site Design Criteria Summary:

SITE	FOUNDATION OPTIONS	ALLOWABLE DESIGN VALUES
SOUTH HILL	SHALLOW - SPREAD FOOTING OR MAT FOUNDATION	5000 psf BEARING PRESSURE (DEAD PLUS LIVE LOADS) 6650 psf BEARING PRESSURE (TOTAL LOADS)
	DEEP - CAST IN PLACE OR DRILLED PIER FOUNDATION	1000 psf SKIN FRICTION DOWNWARD (DEAD PLUS LIVE LOADS) 1330 psf SKIN FRICTION (TOTAL LOADS DOWNWARD) 665 psf SKIN FRICTION UPLIFT (TOTAL LOADS) 1500 psf PASSIVE PRESSURE
FOREST HILL	DEEP - DRILLED CAISSONS	500 psf SKIN FRICTION DOWNWARD (DEAD PLUS LIVE LOADS) 665 psf SKIN FRICTION DOWNWARD (TOTAL LOADS) 300 psf SKIN FRICTION UPLIFT (TOTAL LOADS)

A summary of each site's shelter requirements and soils report availability is shown below:

SITE	REQUIRE NEW PREFABRICATED SHELTER	SHELTER SIZE (Approx.)	AVAILABLE SOILS REPORT
Forest Hill	Yes	11'X11' **	Yes
One Market Plaza	No*		No
South Hill	Yes	10'X10' **	Yes
Twin Peaks	No *		Yes
Bernal Heights	No *		No

USE EXISTING SHELTER/FACILITY.

****SHELTER SIZES ARE APPROXIMATE.***

5.3 Electrical and Grounding System Design Requirements

Electrical Systems shall be designed to conform to the standards and requirements described in this Section. The Contractor shall be responsible for all site development.

5.3.1 Primary Power

The electrical design and installation work shall be carried out by Contractor in accordance with the current edition of the National Electric Code (NEC), the relevant sections of the Uniform Building Code (UBC) for the City and County of San Francisco and/or other applicable codes.

The initial incoming power service feeder, to be run by the electrical utility company, shall be sized for the full capacity of the facility. Future expansion shall also be considered when determining the feeder size. The power transformer shall be placed as close as possible to the facility to improve protection in the event a lightning strike or power surge occurs further down the line.

The Contractor shall conduct a site survey and evaluate the capacity of the existing regular power and existing back-up power. The Contractor shall be responsible to notify the local utility to increase the incoming power to meet the new electrical power requirements. The Contractor shall notify the local utility before engaging in work which requires the presence of an inspector.

Electrical surge and transient protection shall be provided on incoming power lines at all sites. Current City and County of San Francisco sites already have surge and transient protection. Dual-redundant protection is required for AC utility circuits. If the primary protection device self-sacrifices due to a lightning strike, the secondary protection will protect the site until the primary can be replaced.

All suppression devices will utilize Normal Mode (Line-Neutral) protection. The use of MOV protection as the primary and only protection for the incoming power feeder is not permitted.

Common Mode suppressors are not acceptable. The AC neutral shall be bonded to ground ONLY at the main AC service panel.

Main AC panel protectors shall be installed at every site. Regardless of the method of protection chosen, lead lengths from the protection devices(s) shall be made as short as possible. All panel protectors must be wired through a circuit breaker used as a disconnect to the protection, allowing servicing without disturbing site power. Protectors will provide a minimum of 250 Joules of Silicon Avalanche Diode (SAD) protection in combination with a minimum of 5000 Joules of secondary Metal Oxide Varistor (MOV) protection. The secondary protection is necessary if the surge is sufficient to cause the Primary (SAD) device to self-sacrifice. Relay closures must be provided for all primary failure alarms.

5.3.2 Grounding Systems

All equipment shall be electrically bonded and grounded. These include but shall not be limited to cabinet, metal conduits, cable tray, equipment racks, battery racks, chassis, shelves, antennas, and transmission lines.

The contractor shall verify the condition of grounding at all existing sites. Upgrading deficiencies in grounding at existing sites shall be the Contractor's responsibility. The Contractor shall furnish and install all grounding and bonding conductors and make connections to and improve the condition of the grounding at existing sites. The contractor shall furnish grounding at new sites.

Single point ground systems installed within equipment shelters or rooms shall be connected to the exterior building/tower ground system.

A suitably-sized ground window shall be installed at the point where antenna transmission lines enter the shelter, with a building connection and any external ground system using a #2 AWG or larger solid or stranded green jacketed copper conductor. If this conductor extends below the earth's surface, the conductor shall be tinned and any splices shall be made with the exothermic process (Cadweld or equivalent). For equipment located within a building and with antennas located on or within the building, the ground must however be connected to any facility grounds as identified in Section 800-40, NEC. If a tower or other antenna support structure is installed, the ground window shall be bonded to the support structure ground system as well as the building ground system.

Where the shelter, building, or room contains more than one communications system, multiple ground windows shall be used for each system. Each ground window would then be connected with a #2 AWG or larger solid or stranded green jacketed copper conductor to the main, single-point ground window.

Interior halo ground rings shall be installed in shelters, buildings, or rooms specifically designed or designated for communications equipment. They shall also be installed in areas where there is a need to bond system or equipment support apparatus to the ground window. Examples include battery racks, HVAC equipment, doors and door frames, electrical panels and transfer switches, An interior halo ground ring is not required in rooms or areas that are within another larger building where support apparatus, such as items listed above, are not present and the doors or door frames are not metallic or can be grounded via a #6 AWG stranded copper green jacketed conductor run directly to the single point ground. When the internal halo grounding ring is installed, it shall encircle the interior of the shelter, building, or room where the equipment is installed, with opposite ends of the halo conductor connecting to the interior single point ground window.

Upon entering the building, all RF transmission lines, including unused spares, must contain a surge suppresser. The surge suppresser shall be connected to the single point ground window. The suppresser shall be spaced a minimum of two inches from any ancillary equipment, such as cable trays, to prevent flashover in the event of a lightning strike. The surge suppresser must be placed within two feet of the building service entrance.

RF transmission lines from the antenna, down the tower, and into the building shall be grounded as described below.

5.3.3 Ground Bus

In situations where it is necessary to minimize the number of ground conductors connected to the ground window, a ground bus shall be used. Each single row of equipment shall have a separate ground bus consisting of an AWG #2 or larger solid or stranded green jacketed copper conductor. Each bus shall be connected to the single row may be connected to the ground bus. The equipment connection shall be made with AWG #6 or larger solid or stranded green jacketed copper conductors.

5.3.4 Equipment Grounding Connections

Installation of any single cabinet, rack, or enclosure and any transmission line or circuit protection devices associated with this single cabinet, rack, or enclosure shall have an equipment grounding conductor bonding all components to a single point ground bus located near the equipment installation. This single point ground bus consisting of AWG #2 or larger solid or stranded green jacketed copper conductor shall be extended to the single point ground connection or directly to an exterior ground system which is bonded to the electrical service ground.

Installation of multiple cabinets, racks, or enclosures, and any transmission line or circuit protection devices associated with these multiple items that are installed in an area not solely dedicated to the installation of communications equipment shall be connected by the designated size and type of grounding conductors to a single point ground window located near the equipment installation within the same equipment shelter, building, room, or area. This single point ground window shall be connected with AWG #2 or larger solid or stranded green jacketed copper conductor extending to a suitable building ground connection or to an exterior ground system which is bonded to the electrical service ground.

5.3.5 Ground Conductor Length

All grounding conductors shall be kept as short as possible to reduce the radio frequently impedance to ground. The shortest practical ground route with the least number of bends shall be chosen provided the chosen route does not interfere with the equipment or create a safety hazard.

5.3.6 External Grounding Systems

The external grounding system shall establish a 5 ohm or less reading, as measured by the “fall of potential” testing procedure. Due to varying soil resistances caused by geographic composition, modifications to this standard may be accepted. In no case shall a final resistance value greater than 5 ohms be accepted.

The external grounding system shall consist of a buried perimeter ring encircling the shelter foundation, generator foundation, and tower support foundation. In the event these foundations are not located immediately adjacent to one another, individual perimeter loops shall be provided for each system. These loops shall be interconnected by tying two points of each loop to two points of each adjacent loop.

The external ground conductor shall be installed 30 inches below final grade, or inches below the local frost line. It shall be placed a minimum of 24 inches off the concrete foundations, with a minimal bending radius of 12 inches. All buried connections shall be of the exothermically welded type.

From the ground loops, lateral runs shall extend to all above ground fuel tanks, electrical service and generator frame. A minimum of two connections shall be made to the fence. The ground loops and laterals shall be a minimum of #2 solid bare soft drawn tinned copper conductors. Ground rods of 5/8 inch X 8 foot tinned copper clad steel shall be installed at the following locations:

1. Each corner of the perimeter loop encircling the shelter.
2. At intervals between the corner rods, spacing to be no greater than 16 feet or less than 8 feet.
3. Monopoles shall be grounded with a minimum of 4 ground rods. A lateral shall be brought from each rod and connected to the monopole base via an exothermic weld.
4. Self supported and guyed lattice towers shall be grounded with a ground rod adjacent to each tower leg. A lateral shall be brought from each rod and connected to the leg base via an exothermic weld.

The SFMTA may accept suitable alternatives. Alternative methods such as radial copper wire patterns, soil enhancements, or chemical ground rods may be considered on a case by case basis.

5.3.7 Power Back-up Systems

To meet the specified availability requirements in **Appendix Twelve (12), Section One (1)**, the Contractor shall utilize back-up power systems for all critical subsystems and system components.

Remote site equipment is broken down into two categories: Critical and non-critical. Critical equipment includes equipment which, if “down”, would result in an unacceptable drop in the grade of service to the combined MTMS and PSVRN. Examples of “Unacceptable” include:

- A reduction of 10% in the capability of the combined MTMS and PSVRN radio to carry traffic due to trunked channels becoming unavailable.
- Coverage dropping below 90% (on-street level)
- The MTMS and/or PSVRN going into failsoft (loss of trunked operation).

Back-up power sources at existing sites may be used, if the added load of the Contractor provided equipment plus the present connected loads, does not exceed 75% of the designed capacity of the existing back-up system. The Contractor is encouraged to recommend the optimum configuration for remote sites and other constituent systems. This recommendation shall be based on the load analysis, and the power back-up availability at some of the existing remote sites. The Contractor must conduct a site survey and evaluate the capacity of the existing back-up power.

During Intermediate and Final Design the Contractor shall perform fall-back and criticality analysis and identify critical equipment.

5.3.8 Generators

The standby generator system shall be designed to use diesel fuel and supply adequate power for the duration of the outage. Fuel capacity shall provide for no less than 48 hours of continuous backup power at full load. The standby generator system shall be designed considering maintenance and type of operation.

The Contractor shall be responsible to do a load study based on existing conditions and new equipment loads to evaluate the existing diesel generator and determine if an upgrade is required. Additionally, the generator shall be sized for 25% growth.

The standby generator system shall include the following features:

1. Transfer switches for two (2) modes of back-up operation:
    - Mode 1: Automatic backup if primary power fails
    - Mode 2: Manual switch over to connect a portable generator in the event the primary generator fails to the site power through a connector similar to an Appleton connector.

2. An Automatic Transfer Switch that shall at a minimum:
    - Provide adjustable voltage sensors and time-delay monitors.
    - Be capable of sending the following alarms to the Network Management System:
        - Low power
        - Low fuel
        - No start-up

5.3.9 Uninterruptible Power Supplies (UPS)

The Contractor shall supply an Uninterruptible Power Supply (UPS) for each radio site. Existing UPS units at the sites may be used if they have sufficient capacity for current and growth loads.

The UPS shall have 4 hours capacity at 75% full load. Battery and battery charging equipment shall be sized to accommodate all equipment supplied plus 25% of additional capacity.

The UPS shall have alarms, monitored by the Network Management System, for, at a minimum:

- By-pass operation
- No primary power.

Cables and wires for power shall be sized to prevent a voltage drop which may affect the operation of any equipment under full load. Conduit must be installed for any run of power over 5 feet.

5.3.10 Lighting

All equipment room lighting shall be 100 foot-candle with lighting placed over the space between the racks. The Contractor shall provide a dual 40 w Fluorescent fixture in each 8 ft aisle near the blind end with additional fixtures along the aisle at the end of the rows.

The Lenox Way Central Control theater lighting shall be 50 foot-candle.

Operator console task lighting at the Lenox Way Central Control facility shall be 100 foot-candle.

Emergency operating lighting is 20 foot-candle.

5.4 Lenox Way Operations Control Center

5.4.1 General Notes

The Contractor shall reconfigure the existing Lenox Way Operations Control Center as shown in **Appendix Nine (9).** Rubber-tire dispatchers shall be temporarily relocated to the One South Van Ness Line Management Center, leaving room in the Lenox Way theater for renovations. Construction staging drawings are shown in **Appendix Nine (9)**.

5.4.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Prepare a detailed review of the site and document existing conditions in detail.
- Prepare a detailed plan for the phased relocation of equipment and the renovation work
- Coordinate Lenox Way work with complimentary relocation work that the SFMTA will accomplish
- Work shall not start until the SFMTA is satisfied with the proposed renovation/ relocation plan.
- Perform a load study of the AC and DC power system at Lenox Way that includes the new consoles /radio equipment and that includes the equipment resident on the system at each phase in the renovation plan.
- Perform a HVAC study of the Lenox Way site that includes all of the existing equipment and people and the new consoles/radio equipment and that includes the equipment resident at the site at each phase in the renovation plan.
- During construction deactivate the gas based fire suppression system and provide alternative, non-water baser fire suppression equipment. Prepare an expert review of the existing gas fire suppression system. Prepare any necessary work to make the suppression system compatible with the new facility configuration.
- Relocate rail operator consoles to the right side of the existing control room. Erect a partition between the active control room and the work site. This boundary shall be an effective barrier to dirt, dust sound and other distractions that may hinder the uninterrupted operation of the site.
- Renovate the left side of the room. Remove old wiring, cables, tray, etc from below the floor. Remove the ceiling tiles and floor tiles.
- Re-outfit the room with new floor, ceiling, lighting, HVAC ducts, consoles, electronics and displays.

- Relocate the mimic board from the current location to the new interim location. Close up the hole in the wall that is caused by the removal of the panel. (The Contractor shall investigate an alternative plan to relocating the mimic board. This plan will include the installation of video cameras to observe the mimic board in its existing location. Monitors will be located with the relocated light rail personnel.)
- Install new flat displays as required for coordinated operations.
- Relocate the rail operations personnel into the new console positions in the left end of the room. Temporarily relocate the Voice Recorder to the left side of the room.
- Renovate the right end of the room in a complimentary manner.
- Complete the renovation to integrate the two parts of the room into a finished facility.
- Reactivate the gas based fire suppression system.
- Start-Up all systems using vendor help as appropriate. Prepare a detailed test procedure for The SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

The Contractor shall provide the following calculations and plans, to be developed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-1 Lenox Way Site Calculations and Reports].**

Electrical:

- Detailed Electrical Load Study including the entire complex
- HVAC load Calculation including the entire complex

Provide a detailed plan for the renovation of the Control Room that includes consideration of:

- Relocation of people and equipment
- Isolation of operating personnel from construction activity
- Protection of vital circuits, HVAC, lighting and power during construction.
- Protection of systems that will not be replaced such as the gas fire suppression system.
- Removal and replacement of control room infrastructure.
- Inspection of the FM200 gas fire suppression system and an assessment of its effectiveness.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-2 Lenox Way Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-3 Lenox Way Completed Materials Specifications]**

5.4.3 Civil/Architectural

Console furniture shall be provided to accommodate the dispatch workstations and their use by dispatchers and train controllers. It shall be of modular, ergonomic design, and provide the following features:

- MTMS and PSVRN Workstation storage
- Convenient height-adjustable writing surface
- Drawers and storage space
- Power outlet strips
- Design for neat and safe cable runs and connections such as internal cable guides and covered knockouts
- Design for headset jacks
- Comply with ADA regulations
- Comply with state and local seismic bracing requirements.

The Contractor shall be responsible for any Civil/Architectural improvements required to accommodate newly installed equipment.

Architectural drawings for Lenox Way Operations Control Center are contained in **Appendix Nine (9).**

5.4.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

As part of the reconfiguration effort at Lenox Way, the Contractor shall remove all unused wire and cable beneath the control center theatre floor.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9).**

5.4.5 Mechanical

The Contractor shall be responsible for any mechanical improvements required to accommodate all newly installed equipment.

5.5 One South Van Ness Line Management Center Facility

5.5.1 General Notes

The One South Van Ness Line Management Center (8th Floor) will be used as a temporary area for rubber-tire dispatchers while renovations are performed at the 131 Lenox Way Operations Control Center.

5.5.2 Civil/Architectural

The Contractor shall be responsible for any Civil/Architectural improvements required to accommodate newly installed equipment.

The Contractor shall be responsible for modifying the existing Line Management Center dispatch workstation furniture to accommodate MTMS and PSVRN workstations.

5.5.3 Electrical and Grounding

The Contractor shall be responsible for any upgrades or improvements to electrical circuits for installed equipment.

5.5.4 Mechanical

The Contractor shall advise the SFMTA in a timely manner of any mechanical improvements required to accommodate newly installed equipment.

5.6 Bernal Heights Communications Facility

5.6.1 General Notes

The Bernal Heights Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The Bernal Heights Communications Facility shall serve two purposes:

- Above ground radio communications facility for the MTMS and PSVRN systems
- Equipment room facility for MTMS and PSVRN central site equipment, servers, combiners, network core, etc.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.6.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Repair floor and seal walls.
- Install gas based fire suppression system.
- Install a revised power system to provide sufficient power for the existing and the new radio equipment in the room.
- Provide a detailed heat load study to determine if the existing HVAC system will accommodate the additional SFMTA radio equipment. Provide a revised design if required.
- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, power distribution and cable ladders.
- Install antenna mounting appliances on the existing tower to support the new antennas. Provide a structural analysis of the new hardware and a copy of a structural analysis of the tower subsequent to the addition of the antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G.
- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Start-Up all systems using vendor help as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-4 Bernal Heights Site Calculations].**

Electrical:

- Detailed Electrical Load Study including the City Radio equipment.
- HVAC load Calculation based on new and existing loads and existing HVAC equipment.
- Generator Loading Study

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Structural Analyses of the existing tower without and with the new antennas. (The tower is owned by American Tower and is a unique AT&T design.)

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-5 Bernal Heights Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-6 Bernal Heights Completed Materials Specifications].**

5.6.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.6.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9).**

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter #86R904
- Diesel Generator: 40 kW, 120/208V, 3 phase, 4 wire.
- UPS is 850VA
- Incoming for House Service Panel: 1000A breaker
- Fail soft mode, the phase current is 38A, 48A, 48A (with two AC on at the same time).

5.6.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in **Appendix Nine (9)**.

5.7 Central Radio Station Twin Peaks Communications Facility

5.7.1 General Notes

The Central Radio Station (CRS) Twin Peaks Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The CRS Twin Peaks Communications Facility shall serve two purposes:

- Above ground radio communications facility for the MTMS and PSVRN systems
- Equipment room facility for backup network core equipment.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.7.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Confirm that the existing site HVAC equipment will be sufficient to support the new SFMTA radio equipment heat load.
- Install at least two wall hung, 10 pound CO2 portable fire extinguishers in the area of the SFMTA equipment.
- Install a supervised fire alarm system covering the MTA occupied radio room. This alarm panel shall be supervised by a MTA, 3rd party contract remote fire alarm monitoring company.
- Confirm that the existing UPS has sufficient capacity to support the new SFMTA radio equipment.
- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, ground bar and power distribution.
- Provide a structural analysis of the tower after the installation of the new SFMTA antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G.
- Install a means to structurally restrain all hardware including: racks and cable ladders, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Start-Up all new systems. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-7 CRS Twin Peaks Site Calculations].**

Electrical:

- Detailed Electrical Load Study including the City Radio Room
- HVAC load Calculation.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Structural analyses of the existing tower without and with the new antennas.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-8 CRS Twin Peaks Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-9 CRS Twin Peaks Completed Materials Specifications].**

5.7.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.7.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9).**

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter: #9752R2
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.854KW
- "UPS #1" has two 40KVA UPS. Under normal conditions, each UPS carry half load, or approximately 15% load capacity. When one fails, the other one will carry the full load. (about 30% load capacity).
- "UPS #2" is a 60KVA, GE LP 33 Series, 288V, 117.37 Amps, at 23% average load capacity.

5.7.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in **Appendix Nine (9).**

5.8 Forest Hill (Mendosa Avenue) Communications Facility

5.8.1 General Notes

The Forest Hill Communications Facility houses existing City and County of San Francisco (CCSF) equipment (not to be confused with the SFMTA Forest Hill Muni Metro station). The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The Forest Hill Communications Facility shall house above ground radio communications facility for the MTMS and PSVRN systems.

The SFMTA plans to construct a Interim Shelter to house its existing equipment.

The Contractor shall relocate the SFMTA's existing equipment from the Existing Radio Shelter to the Interim Shelter. After installation of equipment in the Interim Shelter, the Contractor shall connect the equipment to existing power feeds, connect antennas, and network equipment to make usable and operable on the existing SFMTA radio system. Temporary antenna installation on the water tank may be required. After this work is complete and accepted by the SFMTA, the Contractor shall be permitted to renovate the interior of the Existing Radio Shelter to house the new PSVRN and MTMS equipment.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.8.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Provide a detailed heat load study to determine if the existing HVAC system will accommodate the additional SFMTA radio equipment. Provide a revised design if required.
- Provide a detailed electrical load study to determine that the existing shelter power system has sufficient capacity to support the new SFMTA radio equipment.
- Provide a detailed electrical load study to determine that the existing shelter power system has sufficient capacity to support the new SFMTA radio equipment and the existing SFMTA radio equipment when it is relocated in the interim building. If there is not sufficient power capacity, provide a design to upgrade the service.

- Provide an interim radio shelter, located in the Forest Hill compound, that is sufficient to house the existing SFMTA radio equipment during the period of new construction, testing and cut-over. The shelter shall provide all necessary support services including but not limited to: access control, internal environmental regulation, lighting, cable management, seismic restraint, fire suppression, fire detection and alarm, etc. (Note, the required location of the Interim Shelter places restrictions on site access and may also place constraints the construction process.)
- Install interim conduits from the existing shelter to the interim shelter for: power, radio communications, alarms and grounding.
- Install Interim antennas on the top of the existing tanks. Provide a structural analysis to confirm the ability of the existing tank structure to support the interim antennas.
- Install an interim cable ladder from the existing shelter to the interim shelter. The bridge shall support the cables for: power, radio communications, alarms and grounding. A portion of the bridge will carry antenna cables from the interim shelter to the existing tower.
- Install supporting infrastructure for the new radio equipment including but not limited to: grounding, power distribution and cable ladders.
- Install antenna mounting fixture appliances on the existing tower to support the new antennas. Provide a structural analysis of the new hardware and a copy of a structural analysis of the tower subsequent to the addition of the antennas. The analysis shall conform to the requirements of ANSI/TIA-222-G. The analysis shall include the consideration of having both the existing SFMTA antennas and the new SFMTA antennas on the tower at the same time.
- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the SFMTA facility to survive a seismic event.
- Prepare a detailed plan for the relocation of the existing SFMTA radio equipment from the existing shelter to the new shelter. The plan shall include consideration of the following factors: the impact on the SFMTA communications system when the Forest Hill site is incapacitated; The potential for operational compensations for the temporary loss of the Forest Hill site; the time and day when the loss of the Forest Hill radio equipment will have the least impact; the process required for re-starting the radio equipment after relocation.
- Start-Up all new systems using vendor resources as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-10 Forest Hill Calculations].**

Electrical Calculations:

- A detailed Electrical Load Study including the current load, the interim load and the final load.
- HVAC load Calculation.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- The tower structural analysis shall be based on ANSI/TIA-222-G.
- Structural analyses of the existing monopole without and with the new antennas.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-11 Forest Hill Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-12 Forest Hill Completed Materials Specifications].**

5.8.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.8.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9)**.

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter X01869.
- Last year, PG&E reported a peak value of 26KW
- UPS is 850VA
- Diesel Generator is 100kW/125kVA, 120/208V, 3Ø, 4W
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW.

5.8.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in **Appendix Nine (9)**. The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

5.9 One Market Plaza Communications Facility

5.9.1 General Notes

The SFMTA is currently investigating the feasibility of leasing additional space at One Market Plaza to accommodate the MTMS and PSVRN equipment.

The Contractor is advised that all electrical, mechanical, and civil/architectural work performed at this site shall be performed by the building management association's approved contractor(s). In such case, the Contractor shall be required to execute a subcontract with the approved contractor(s) to perform any necessary work at this site. Qualified Proposers may request the list of building management association's approved contractor(s) from the SFMTA.

The Contractor shall verify whether the existing building structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.9.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Renovate the designated room and prepare it for re-construction
- Install a City approved pre-action, dry pipe fire suppression system that is connected to the building fire alarm system.
- Install a new emergency power system with the basement located emergency generator. This power system shall support both the SFMTA equipment room and the City Radio Equipment room. A complete and detailed load study shall be completed. The drawings indicate the anticipated result of this task and are not prescriptive. The emergency generator shall be cooled by the existing building chilled water system.
- Install a dual, redundant room cooling system that will maintain a 70 degree F atmosphere for all of the anticipated radio equipment and an additional 50% of the anticipated cooling load. This system shall use existing building chilled water and shall be supported by the emergency generator.
- Install a room grounding system that is connected to both the building steel frame and to the building electrical ground system.
- Install room support systems including but not limited to: lighting, cable ladder, racks, power distribution, etc.
- Install antenna mounting fixtures that are attached to the building steel frame and that comply with all applicable codes including ANSI/TIA-222-G.
- Install necessary means so that antenna cables shall not be visible from outside the building.

- Install a means to structurally restrain all hardware including: racks, pipes, cable ladders and tanks, in a manner that satisfies local seismic requirements and that permits the facility to survive a seismic event.
- Start-Up all systems using vendor guidance as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA. (The gas based fire suppression shall be tested without actual agent discharge.)

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-13 One Market Plaza Site Calculations].**

Electrical Calculations:

- Detailed Electrical Load Study including the City Radio Room
- HVAC load Calculation
- Generator Loading Study.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Analysis of the capacity of the penthouse to support additional antennas.
- Analysis of the proposed antenna mounting hardware and attachment methods.
- Floor loading.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-14 One Market Plaza Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-15 One Market Plaza Completed Materials Specifications].**

5.9.3 Civil/Architectural

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

5.9.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9).**

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- Transformer: 45KVA
- Diesel Generator: 600KW/ 750KVA, PF 0.8
- UPS: 850VA
- Lighting load: 640W
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW.

5.9.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in **Appendix Nine (9)**. The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

HVAC control sequence of operation is listed below (see reference drawing in **Appendix Nine (9)**):

- ACU-1 AND ACU-2, In conjunction with a DDC programmable controller , shall be programmed to run one (1) ACU continuously. The second unit shall operate as a stand-by unit and shall be programmed to start whenever the lead unit fails. ACU-1 and ACU-2 shall be alternately selected to function as the stand-by unit for a period of one month.
- The fan corresponding to selected unit shall run continuously.
- Thermostats T-1 and T-2 corresponding to ACU-1 and ACU-2, respectively shall control the cooling functions of their corresponding ACU unit to maintain space temperature at 75° F.
- Humidity sensor H-1 and H-2 corresponding to ACU-1 and ACU-2 respectively shall control their corresponding humidifier to maintain room humidity at 50% relative humidity.
- Detection of smoke by smoke detectors SD-1, SD-2 (LOCATED RESPECTIVELY IN ACU-1 and ACU-2) or an area smoke detector in conjunction with the fire control panel, shall shut down air conditioning units with ACU-1 and ACU-2, and disable EF-1.
- Detection of smoke shall also cause the fire control panel to close new supply and return dampers connected to radio room air ducts (if applicable-See <3>); and emergency air damper connected t outside air louver.
- Condenser water pump CWP-1 or CWP-2 in conjunction with the DDC programmable controller shall be programmed to run continuously. Condenser water pump CWP-1 and CWP-2 shall be alternately selected to functions as the lead pump for a period of (1) one month.
- The DDC programmable controller in conjunction with flow switch FS-1 or FS-2, respectively located at CWP-1 and CWP-2, shall sense failure of the lead pump CWP-1 or CWP-2 and start the lag pump.
- When temperature sensor TS-1 detects a room temperature rise to 90° F, the stand-by ACU and stand-by CWP shall be programmed to operate. Both ACU-1 and ACU-2 will operate simultaneously until the room temperature falls to 75° F.

- When both ACU-1 and ACU-2 fails, the emergency outside air damper shall be programmed to open and EF-1 shall be programmed to start.
- When the remote indicators sense a problem (I.E., fan failure of ACU-1 and ACU-2, failure of CWP-1 or CWP-2, Activation of both ACU-1 and ACU-2 activation of EF-1, etc.), a signal shall be sent to the SFMTA SCADA System.

The Network Management System (**Appendix Twelve (12), Section Four (4)** shall, at a minimum:

- Monitor activation of either HVAC system, including which system(s) is in operation
- Monitor problem/fault indicators
- Monitor room temperature and humidity.

5.10 South Hill Communications Facility

5.10.1 General Notes

The South Hill Communications Facility in Daly City houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The South Hill Communications Facility shall house above ground radio communications facility for the MTMS and PSVRN systems.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.10.2 Preliminary Scope of Work

The following preliminary assessment is provided for work at this site, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Install a new emergency power system including a new emergency generator. This power system shall support both the new SFMTA shelter and the existing City Radio Equipment shelter. A complete and detailed load study shall be completed. The drawings indicate the anticipated result of this task and are not prescriptive.
- Perform a detailed subsurface investigation of the site in preparation for designing the foundation for a new radio equipment shelter.
- Install a complete site ground system that integrates the new shelter and the existing shelter and tower grounding system.
- Provide and install a new radio equipment shelter within the South Hills compound. The new shelter shall incorporate all necessary and desirable infrastructure features needed to support the new radio equipment. These features shall include but not be limited to: access control, internal environmental regulation, lighting, cable management, seismic restraint, fire suppression, fire detection and alarm, and etc.
- Install an antenna cable bridge between the new shelter and the existing tower.
- Provide an analysis of the existing tower with the new SFMTA antennas installed. Determine if the existing tower and the new antenna loads necessitate the extension of the tower to its optional 40 foot height. Provide a structural analysis of the new hardware and the final configuration of the tower. The analysis shall conform to the requirements of ANSI/TIA-222-G.
- Start-Up all systems using vendor resourced as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

During construction the following inspections will be performed by the SFMTA unless otherwise formally notified:

- Inspection of all foundations excavations prior to installation of rebar
- Inspection of all foundation construction prior to the pouring of concrete
- Observation of on-site Concrete Quality Tests
- Inspection of site ground system prior to backfilling.

The Contractor shall provide the following calculations, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-16 South Hill Site Calculations and Tests].**

Soils:

- Ground Resistance Tests
- Sub-Soil Hazard inspection.
- Soil Stability Report
- Concrete Hardness.

Electrical Calculations:

- Detailed Electrical Load Study including the existing City Radio Shelter
- Generator loading study.

Structural Calculations (to be stamped and signed by a Registered Structural Engineer licensed in California):

- Tower structural analysis based on ANSI/TIA-222-G.
- Structural analyses of the existing tower without and with the new antennas. This calculation shall reflect the need to add the additional optional tower section.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-17 South Hill Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-18 South Hill Completed Materials Specifications].**

5.10.3 Civil Architectural

The Contractor shall be required to construct a new communications shelter to accommodate the PSVRN and MTMS equipment at this site.

The Contractor shall perform any required Civil/Architectural work at this site required to accommodate the MTMS and PSVRN equipment.

Civil/Architectural drawings are contained in **Appendix Nine (9).**

5.10.4 Electrical and Grounding

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

Electrical and Grounding drawings are contained in **Appendix Nine (9)**. Network connectivity drawings are also contained in **Appendix Nine (9).**

Existing conditions are provided here for reference only and should be verified prior to any design or construction activity:

- PG&E meter #8078R3
- UPS is 850VA
- Department of Emergency Management's new load requirements, to be added as part of a CERS system upgrade are approximately 3.56KW
- The existing incoming service is in a 3" conduit originates down the hill, from the PG&E service pole to the existing prefab.
- The distance from PG&E transformer to panel is approximately 434 feet.
- Diesel Generator is 40kW/50kVA, 120/208V, 3Ø, 4W.
- Existing loads as follows:

Peak Readings					
Fail soft mode	**Phase A**	**Phase B**	**Phase C**	**Power**	**PF**
Both AC off	**42 A**	**29 A**	**58 A**	**18KW**	**.98**
1 AC on (in rush)	**66 A**	**67 A**	**72 A**	**22KW**	**.99**
	211V	**211V**	**210V**		

5.10.5 Mechanical

The Contractor shall perform any required mechanical work at this site required to accommodate the MTMS and PSVRN equipment.

Mechanical drawings are contained in **Appendix Nine (9)**. The Contractor shall be responsible for performing any mechanical or HVAC upgrades required to accommodate the MTMS and PSVRN equipment to be installed.

HVAC control sequence of operation, including NMS requirements, are listed above in Section 5.8.4 for One Market Plaza.

5.11 Clay and Jones Communications Facility

The Clay and Jones Communications Facility houses existing City and County of San Francisco (CCSF) equipment. The SFMTA wishes to co-locate MTMS and PSVRN equipment at this site with the CCSF equipment. For the SFMTA, The Clay and Jones Communications Facility shall house a single 800 MHz repeater for cable car machinery maintenance operations.

The Contractor shall install a new 800 MHz repeater in the CCSF designated area. The existing 800 MHz repeater shall be removed and returned to the SFMTA, and the area within which it was installed cleaned up.

The Contractor shall perform any required electrical and grounding work at this site required to accommodate the MTMS and PSVRN equipment.

The Contractor shall verify whether the existing tower structure can accommodate the new MTMS and PSVRN antennas and feed lines.

5.12 Underground Communications Facilities

Functional requirements for the underground radio communications requirements are listed in **Appendix Twelve (12) Section Two (2)**.

The Contractor shall be responsible for performing civil/architectural, mechanical, electrical, grounding, and any other work to implement the underground portions of the MTMS and PSVRN communications systems.

Underground communications drawings are contained in **Appendix Nine (9)**.

The Contractor shall perform all underground work in accordance with the Special Provisions listed in **Appendix Three (3), "Form of Agreement"**. This shall include all the SFMTA imposed restrictions on time allowed to work in the underground tunnels, advanced notice for work schedule, etc.

The following preliminary assessment is provided for work in underground tunnels, platforms, and passageways, including, but not limited to:

- Review and confirm the site description on the Cover Sheet for the work site**.**
- Prepare for the SFMTA review and approval, a plan for the implementation of the SFMTA required track safety training and track safety supervision.
- Prepare for the SFMTA review and approval, a plan including tunnel/track access and work that reflects the need to maintain revenues services and train schedules.
- Prepare a detailed plan for a tunnel survey to confirm information shown on the drawings.
- Perform the tunnel survey.

- Do the necessary RF engineering to demonstrate that the selected communications technology will provide the desired communications coverage and service reliability. See **Appendix Twelve (12) Section Two (2)** for coverage and performance requirements.
- Prepare a complete tunnel radio system design showing all equipment, cables. racks, etc for the SFMTA review and potential approval.
- Install all required cable mounting hardware and cables.
- Install all in-tunnel electronics and power distribution.
- Install all station located electronics and power supplies.
- Install all above ground antennas.
- Coordinate with the SFMTA to provide appropriate electrical power for the station mounted equipment.
- Start-Up all systems using vendor resources as appropriate. Prepare a detailed test procedure for the SFMTA review and potential approval. Conduct an acceptance test of all systems and equipment in the presence of a representative of the SFMTA.

The Contractor shall perform the following calculations and develop reports, to be performed by qualified personnel. Results shall be provided in report format, stamped and signed by a Registered Engineer licensed in California. **[CDRL 12-5-19 Underground Calculations and Reports].**

Reports:

- Track and Safety Plan
- Tunnel Access Plan
- Comparison between radio communications technologies.

Calculations:

The following calculations shall be performed by qualified personnel. The results shall be presented in a report format to the SFMTA for review. The calculation reports shall be prepared and signed by a Registered Engineer licensed in California.

- Power loss and regulation of tunnel power distribution.
- RF power link budget in each tunnel section.

No construction work shall be started nor shall any construction materials be purchased prior to receiving formal approval by the SFMTA of all of the deliverables:

- Completed Construction Drawings **[CDRL 12-5-20 Underground Completed Construction Drawings]**
- Completed Materials Specifications **[CDRL 12-5-21 Underground Completed Materials Specifications].**

5.13 Vehicle Operations and Maintenance Facilities

The SFMTA employs a number of vehicle operations maintenance facilities:

- Potrero Division
- Muni Metro East
- Presidio Division
- Green Division
- Woods Division (separate Operations and vehicle maintenance areas)
- Flynn Division
- Kirkland Division
- Cable Car Barn
- Scott Non-Revenue Division
- Islais Creek (planned future).

Each of these facilities will require the Contractor to perform necessary electrical, grounding, and mechanical work to install the following:

- Network equipment
- Dispatch work stations
- Wireless access points and antennas for high speed bulk data transfer
- Servers for MTMS store-and-forward operations
- Other equipment as required for MTMS and PSVRN operation including control stations, desktop voice consoles, etc.

Drawings showing equipment installation details for each of these sites are included in **Appendix Nine (9).**

5.14 Vehicle Equipment Installations

The Contractor shall install all Contractor provided on-board equipment in the SFMTA's vehicles. The Contractor shall supply all wiring, cable harnesses, connectors, brackets, fuses, and all other hardware required to connect each device to other Contractor-provided equipment, existing vehicle equipment, and the vehicle power supplies. The types and quantities of vehicles requiring installation are listed in **Appendix Twenty Eight (28), "Cost Proposal"**. A final vehicle count will be agreed upon at contract award. The SFMTA reserves the right to adjust vehicle quantities and types for equipment installation subsequent to Contractor NTP.

The Contractor shall work with the SFMTA staff to ensure that installation procedures and equipment locations are acceptable to the SFMTA. The Contractor shall submit, for review and approval, installation plans, installation test procedures, installation procedures, and drawings for each type of vehicle.

It is the Contractor's responsibility to determine and/or obtain all necessary vehicle information to ensure no vehicle equipment is damaged during the installation process. Any damage done by the Contractor during installation shall be repaired by the Contractor at the Contractor's own expense.

The Contractor shall provide documentation and/or evidence that all material and electronic waste removed from the SFMTA's vehicles has been legally and responsibly disposed of and/or recycled.

The Contractor and the SFMTA shall mutually agree on locations, times, and the SFMTA resources provided during installation at each site. In general, installations should be scheduled at times when most vehicles are available and not needed for service. The Contractor shall coordinate installation of equipment on the SFMTA's revenue vehicles with Maintenance supervisors, Resident Engineer, or the other SFMTA staff at each Division.

The Contractor shall provide a Quality Control (QC) representative to randomly select and inspect a percentage of the vehicle installations. The QC representative shall report directly to the Contractor's management and have the authority to direct installers to immediately remedy any deficiencies and/or impose restrictions on installation activities until such deficiencies are corrected.

The Contractor shall remove all existing vehicle antennas, and cabling, replace with new, and test to confirm that the VSWR is less than 1.5:1.

The Contractor shall maintain and deliver installation checklists and equipment inventories for each individual vehicle having equipment installed **[CDRL 12-5-22: Vehicle Installation Details]**. These checklists and inventories shall be delivered for each vehicle after installation is approved.

5.14.1 General Installation Standards

Unless otherwise specified in **Appendix Twelve (12), Section Two 2 "Radio Communications Components"**, system installation shall conform to the following general standards:

- Workmanship and appearance of work throughout shall be of the best commercial quality and adhere to the latest edition of all applicable standards and codes
- Work shall be performed only by qualified personnel, and shall be supervised by technically competent, trained, experienced supervisory personnel at all times
- All equipment and components shall be easily accessible for adjustment and service
- Cabling and equipment exposed to the weather shall be adequately protected from wind, rain, and dust. Seals, gaskets, packing, sheathing, finishes, mountings, and all other exposed items shall be designed for maintenance-free performance under long-term exposure to weather, including ultra-violet radiation.
- Equipment and cabling installed inside buses shall be adequately protected from water and dust, including that present during bus cleaning operations
- Equipment requiring adjustments shall be securely installed inside buses and vehicles using tamper-proof containers, fasteners, etc.
- Wiring and cabling shall be installed using the following standards:
  - Conductors shall be continuous between terminals, without splices
  - Conductor gauge, insulation, and shielding shall be adequate for the intended purpose
  - Cable and wire shall be run neatly, with adequate lacing or clamping
  - Consistent cable and wire color coding shall be used
  - All applications requiring physical movement and flexing shall use stranded conductors
  - Wire and cable shall be labeled every 6 inches.
- Ring-type, crimped lugs shall be used with stranded wires terminated on screw-type terminals. Connections shall be made only with crimping tools that meet the connector manufacturer's specifications.
- Shielded wiring, or other means of signal isolation, shall be used wherever necessary to avoid cross-talk, hum, pops, clicks, whine, and other forms of interference. The Contractor shall provide an interference-free system.
- Unless installed in conduit, wiring within consoles, beneath raised floors, and from outlet boxes to free-standing or desk-mounted equipment shall be neatly installed, bundled with appropriate tie-wrap devices, and tied to supports if practicable

- Dispatch center signal and control wiring, and connection of devices referenced in this Specification, shall be installed in conduits or concealed, and shall be included as part of the work to be performed by the Contractor. Wiring shall be accessible for maintenance. At remote sites and in equipment rooms, open cabling is permitted on cable racks provided they are neatly tied
- Interconnect cabling used within consoles, equipment cabinets, or in areas where the wiring will not be installed in metallic conduit, shall be insulated with heat-resistant material to minimize pyrolysis and fire hazard
- Cable and wiring penetrations through metal cabinets shall be insulated with dielectric grommets
- Cable and wiring installed in modular furniture shall be run in the trays or channels designed for that purpose
- Extra wiring necessary for equipment movement shall be neatly coiled, tied, and concealed
- Wiring in dropped ceiling areas shall not lie on top of light fixtures or ceiling tiles
- Cable penetrations through building outside walls shall be thoroughly packed and waterproofed
- Cables, wiring forms, and terminals shall be identified by permanent labels, tags, or other appropriate means. Marking shall clearly indicate the function or source. Cables shall be identified at both ends with indications of the source and destination of that cable run. The cable identification shall agree with the wiring and interconnect diagrams
- Installation at all sites shall be in complete compliance with all applicable local building, seismic, and fire codes.

5.14.2 Rubber-Tire Vehicle Installation Standards

The following requirements apply to all mobile radio and ITS equipment to be installed in the SFMTA's vehicles.

All the SFMTA vehicle installations shall be subject to inspection and approval before acceptance, by inspection personnel to be named by the SFMTA. Acceptance shall include but not be limited to:

- Appearance
- Effective usefulness
- Full programming as set forth by agreement
- Full testing, including power out, deviation, receiver sensitivity, antenna VSWR, and all programmed features, to meet or exceed published specifications.

Prior to any Contractor testing, the coach electrical supply should be verified as suitable and adequate for proposed equipment requirements. Routing, connections and circuit protection for radio and any on board equipment connectivity shall be inspected and approved by the SFMTA, as part of the mini-fleet test, and carried forward to production installations.

The Contractor shall make every effort to protect all interconnecting cable runs, especially cables routed underneath the vehicle.

All cabling that is routed underneath the vehicle shall be secured in high impact plastic looms and secured to a stationary support device.

Ties to such supports shall be stainless steel straps that are designed for this purpose; nylon tie-wraps are not acceptable.

Care shall be taken to avoid the vehicle exhaust system or other areas that create excessive heat.

Where wiring passes through compartment walls, floors, or rooftops, the Contractor shall protect the wiring from sharp edges with rubber grommets and shall ensure waterproofing to interior compartments.

Installation in any vehicle shall not interfere with any functional device, nor shall it affect the safe operation of the vehicle. On vehicles equipped with driver and passenger side air bags, the Contractor equipment shall not interfere with deployment. If necessary, the Contractor shall propose and install a passenger side air bag disabling switch. Modification of any safety equipment or air bags on the SFMTA's vehicles shall be performed by a US-DOT certified technician and include registration with the California Department of Motor Vehicles.

All vehicles that have tilt cabs shall be provided with new ground braids between the cab and the frame of the vehicle. This ground braid shall be installed on metal that is free from paint, grease, or dirt, and shall include a star lock washer to ensure a reliable and secure ground connection.

All main power leads shall be obtained from the same voltage source as that used by existing radio equipment.

The SFMTA prefers a design that will utilize a single microphone for both radio communications and PA use.

In vehicles that employ intercom systems, the new equipment shall be connected to the intercom system upon cutover to the new radio system. New radios shall be checked for compatibility with the intercom system at the time of installation.

The new equipment shall not create or receive interference from other electronic equipment in the vehicle. If any modification is required to the Contractor's equipment to correct such interference, such correction shall be performed on all vehicles to ensure uniformity of equipment, at no additional cost to the SFMTA.

All fuses shall be installed in locations that are easily accessible. No fuses shall be installed in locations under the vehicle.

All wiring shall be installed in a manner that is secure and free from interference or damage by the occupants.

All antennas shall be mounted permanently to the roof of the vehicle.

No cable connectors fabricated in the field shall be crimp-type. All connectors shall be soldered using 60/40 solder within heat shrink that incorporates some form of sealant to ensure proper connection.

Reflected power, or VSWR, shall be measured after installation of each antenna and cable. Maximum reflected power shall not exceed 4% of the radio unit's output power.

No wiring shall be spliced within the loom covering that wire.

"LOK" or "T-Tap" style splice connectors shall not be permitted.

No wire shall change color between the source and the radio unit.

The Contractor shall be responsible for making corrections to any and all vehicles that experience dormant operation battery drain, where such drain can be attributed to new equipment installation. In such case, the Contractor shall be required to install equipment cut-off timers or other means to prevent dormant loads from draining the vehicle batteries.

The Contractor is encouraged to check vehicle batteries before radio installation to avoid problems. If a vehicle is found to have faulty batteries, the Contractor shall notify the SFMTA and note this on the installation documentation.

5.14.3 Rail Vehicle Installation Standards

Specific rail vehicle installation standards are contained in **Appendix Twenty-Two (22).** These standards, where applicable based on Contractor-provided equipment, shall apply to the SFMTA's fleet of Breda Light Rail Vehicles, cable cars, and the Historic Fleet.

The Contractor's equipment installation on the Historic Fleet shall be subject to additional review and approval by the Market Street Railway (the nonprofit preservation partner of the San Francisco Municipal railway), and other public stakeholder groups. The Contractor's installation on such vehicles should be designed to preserve the historic look and finish existing in each distinct vehicle and/or vehicle type.

The San Francisco cable car is considered a national icon. As such, the Contractor's equipment installation on the vehicles will be subject to additional review and approval by other stakeholder groups. The Contractor's installation on the cable cars should be designed to preserve the historic look and finish existing in each distinct vehicle.

5.15 System Cutover

The contractor shall develop a detailed System Cutover Plan per requirements in this section and other sections of these Specifications and submit the Plan for the SFMTA review and Approval **[CDRL 12-5-23 System Cutover Plan]**. The Plan shall include details for the entire Cutover process even if the specifics are not included herein. Proposers shall submit, as part of their proposals, a Sample System Cutover Plan for a similar system be installed at an agency similar in size to the SFMTA **[PRL 12-5-3 Sample System Cutover Plan]**.

The System Cutover Plan shall describe a smooth transition between the SFMTA's use of existing systems to use of the PSVRN and MTMS, with no effective loss of control over revenue vehicle operations. This plan shall allow for a period of parallel operations of the existing equipment and PSVRN and MTMS. The Contractor shall be responsible for implementing all software and hardware and providing all necessary equipment required to support system phase-over.

The System Cutover Plan shall describe in detail the design and procedures used to support the parallel operation, testing and verification of functionality of the new system, and the transition of operations to the new system. The field performance, "mini-fleet", and full fleet testing to be performed during the cutover phase shall be described in this plan.

The vehicle installation plans shall define how the vehicle installation work will be performed, the sequence in which vehicle installations will be performed (e.g., the order of the installations by Division, site, or vehicle type), the schedule for installing on-board vehicle equipment, and the support and facilities expected from the SFMTA.

The System Cutover Plan shall identify how the contractor shall plan, manage, install equipment, integrate, test, and commission all the equipment for PSVRN and MTMS at all fixed sites illustrated in the drawings contained in **Appendix Nine (9)**, and all of the SFMTA fleet vehicles (rubber-tire fleet, historic fleet, cable cars, electric trolleys, light rail vehicles, and non-revenue service vehicles). Upon written request by

the Contractor, the SFMTA shall make the available drawings and schematics for the vehicles available. Several vehicles such as historic fleet, do not have schematics. The SFMTA does not guarantee nor confirms the accuracy of these documents and the contractor shall thoroughly inspect the vehicles to verify the accuracy of the drawings at no additional cost to the SFMTA.

5.15.1 System Cutover Plan

The Contractor's System Cutover Plan shall include specific details for the SFMTA to comprehend the overall management and control process of the Cutover. As a minimum, the contractor shall include, as a minimum, the following details in the Plan:

i. Overall organization including reporting structure and organization chart

ii. General approach and methodology to manage the Cutover process

iii. Pre-cutover activities and support needed from the SFMTA

iv. Cutover activities and support needed from the SFMTA

v. Post-cutover activities and support needed from the SFMTA

vi. Detailed description of project schedule activities including methodology to control schedule

vii. Work task breakdown, including activities performed by the prime and subcontractors, and system integration in flowchart format

viii. Methodology and approach for QA/QC, configuration control, inspections, labeling, and testing

ix. Safety requirements and precautions

x. Compliance with standards, regulations, and codes

xi. Drawings, reports, and data

xii. Cutover schedule.

This is a partial list of requirements and the contractor shall include additional items based on past experience. The SFMTA or its designee shall have the liberty to request the Contractor to include additional information as deemed necessary for the cutover process.

The System Cutover Plan shall be submitted to the SFMTA prior to beginning Factory Acceptance Testing.

5.15.2 System Cutover Schedule

The Contractor shall develop and Submit for Approval a detailed schedule and associated description of all activities for the cutover including the milestones **[CDRL 12-5-24 System Cutover Schedule]**. The schedule shall be in a time-scaled, bar-chart format indicating the detailed progress of the cutover from the beginning through end. The contractor shall update the schedule and submit it to the SFMTA each week based on the progress. As a minimum the schedule shall include the following details:

i. Completed activities and progress during previous week in narrative format and highlighted on the schedule

ii. Planned and actual progress for each maintenance facility

iii. Key milestones including but not limited to payments, submittals, deliverables, approvals, and tests

iv. Planned activities for the next month.

All milestones, start-dates, completion dates shall be consistent with the contract milestone dates. When predicting future activities, the contractor shall identify the specific support needed by the SFMTA.

5.15.3 Meetings

The Contractor shall schedule dedicated meetings every two weeks and shall send invitations to the SFMTA. The objectives of meetings shall be to provide information, discuss issues, request information, or update the SFMTA of the cutover progress. The duration of meetings may vary based on the type of agenda, however, the contractor shall be responsible for documenting meeting minutes and submitting the minutes to the SFMTA for approval. The meetings shall include:

- The installation progress,
- Issues, concerns,
- Resolution related to the cutover process.

5.15.4 Systems Engineering and Integration During Cutover

As part of the System Cutover Plan, the contractor shall develop a comprehensive and detailed description of how systems engineering and integration will be achieved during the cutover process **[CDRL 12-5-25 System Engineering and Integration Description During Cutover]**. The details shall include specifics including but not limited to:

i. How cables shall be installed and routed

ii. How and where the equipment shall be installed

iii. How and where the power will be tapped from and power utilization

iv. How the vehicle borne equipment will be integrated

v. Hardware and software integration.

This is a minimal list and the contractor shall be responsible for including all pertinent information to the SFMTA. If deemed necessary, the SFMTA may request additional information. Throughout the document references shall be made as needed to each subsystem installation drawings, schematics, installation plans, and other documents as necessary. Generic statements repeating the RFP language shall not be accepted.

5.15.5 Compliance with Standards, Codes, and Regulations

The Contractor shall comply with all applicable standards, codes, regulations, laws and requirements whether specified in these documents or not. The contractor shall ensure that all such requirements are identified within the System Cutover Plan. Whenever there is a conflict between two requirements, the Contractor shall bring it to the SFMTA's immediate attention in writing and the most stringent requirement complying with these technical specifications shall prevail.

5.15.6 Drawings, Reports, and Data

The contractor shall include all necessary drawings, reports, and data as part of the System Cutover Plan. If any drawings, reports, and data are submitted as part of the design package then the System Cutover Plan may reference such drawing, report, or data. If the required documents are not submitted as part of the design then the Contractor shall include such information with the System Cutover Plan. The SFMTA reserves the right to request additional information.

The drawings, reports, and data submitted as part of the System Cutover Plan shall include sufficient details for the reviewer to make an assessment of the subsystem or assembly under consideration. The drawings shall include specifics in appropriate scale and shall include the plan views, side views, transverse sections, longitudinal sections, and clearances as applicable.

All drawings shall comply with the SFMTA's CADD Standard.

5.16 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

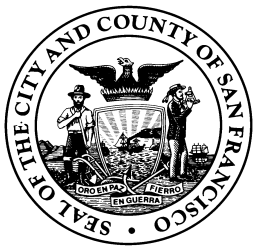
- PRL 12-5-1 Environment Requirements
- PRL 12-5-2 Required Equipment Space
- PRL 12-5-3 Sample System Cutover Plan.

5.17 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-5-1 Lenox Way Site Calculations and Reports
- CDRL 12-5-2 Lenox Way Completed Construction Drawings
- CDRL 12-5-3 Lenox Way Completed Materials Specifications
- CDRL 12-5-4 Bernal Heights Site Calculations
- CDRL 12-5-5 Bernal Heights Completed Construction Drawings
- CDRL 12-5-6 Bernal Heights Completed Materials Specifications]
- CDRL 12-5-7 CRS Twin Peaks Site Calculations
- CDRL 12-5-8 CRS Twin Peaks Completed Construction Drawings
- CDRL 12-5-9 CRS Twin Peaks Completed Materials Specifications
- CDRL 12-5-10 Forest Hill Calculations
- CDRL 12-5-11 Forest Hill Completed Construction Drawings
- CDRL 12-5-12 Forest Hill Completed Materials Specifications
- CDRL 12-5-13 One Market Plaza Site Calculations
- CDRL 12-5-14 One Market Plaza Completed Construction Drawings
- CDRL 12-5-15 One Market Plaza Completed Materials Specifications
- CDRL 12-5-16 South Hill Site Calculations and Tests
- CDRL 12-5-17 South Hill Completed Construction Drawings
- CDRL 12-5-18 South Hill Completed Materials Specifications
- CDRL 12-5-19 Underground Calculations and Reports
- CDRL 12-5-20 Underground Completed Construction Drawings
- CDRL 12-5-21 Underground Completed Materials Specifications
- CDRL 12-5-22: Vehicle Installation Details
- CDRL 12-5-23 System Cutover Plan
- CDRL 12-5-24 System Cutover Schedule
- CDRL 12-5-25 System Engineering and Integration Description During Cutover.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole, or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **six**

Quality Control & Inspection/Quality Assurance

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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6.0 Quality Control & Inspection/Quality Assurance

6.1 Quality Assurance

This section specifies the Contractor Quality Assurance (QA) requirements for the work that shall be performed under the project in conformance with the project Quality Assurance Plan (QAP). It shall be the responsibility of the Contractor to follow and meet the requirements of the Quality Assurance Program (QA Program) for all work performed under the contract. This program and the QAP will also cover the SFMTA furnished contributions. Following the QAP, the SFMTA and Consultants may also conduct Quality Assurance activities, but all Quality Control (QC) activities will be the Contractor's responsibility. This requirement is independent of any acceptance inspection and testing performed by the SFMTA and/or testing and certification organizations.

The Contractor's project Quality Manager shall conduct, at a minimum, quarterly Quality Management Review (QMR) meetings of the project quality assurance program with the SFMTA management to assess its suitability and effectiveness:

- in meeting the requirements of the project requirements and statutory and regulatory requirements,
- in meeting the SFMTA expectations,
- in meeting the requirements of the quality program
- in its compliance with the Federal Transit Administration's fifteen quality elements.

The Contractor's project Quality Manager shall conduct audits and surveillances at planned intervals to determine whether the QAP and the Quality Assurance Program:

- conform to the requirements of the Contract and the fifteen FTA quality elements,
- is effectively implemented and maintained.

The Qualified Proposers shall submit, as part of their proposal, a Sample Quality Assurance Program Plan **[PRL 12-6-1 Sample Quality Assurance Program Plan]**. Within sixty (60) days after issuance of Notice to Proceed (NTP) for the Contract, the Contractor shall submit the QAP with QA Program to the SFMTA for acceptance **[CDRL 12-6-1 Quality Assurance Plan with QA Program]**.

The QAP with QA Program shall include as a minimum the following:

1. An organization chart showing the Contractor's project organization that shows personnel that is involved with the project in a function that affects product or service quality.
2. The Contractor's on-site organization chart including a Quality Assurance organization showing the proposed Contractor Quality Manager and QA Staff.
3. The SFMTA's and the Contractor's commitment to the development and implementation to the QAP with QA Program and transfer of authority to the Quality Assurance personnel.
4. Documented procedures for accomplishing and reviewing work, supervision, inspection, tests, certifications, documentation of QA activities, including those of subcontractors for all on-site and off-site work under the Contract.
5. Documented procedures and instructions for Quality Assurance personnel, construction supervisors, managers, subcontractors and suppliers.
6. The coordinating procedures and authorities concerning the work activities performed off-site and not under the direct supervision of the Contractor Quality Manager.
7. Evidence of the competence of QA personnel in meeting the requirements of the QAP.

The Contractor Quality Manager shall report to the SFMTA Resident Engineer, and coordinate quality surveillances and audits with the SFMTA or Consultant auditors, as needed.

A sample Quality Assurance Plan is located in **Appendix Ten (10)**.

6.2 Contractor Responsibilities

The Contractor shall be responsible for the following areas, including but not limited to:

- Engineer of Record for Construction Phase when the final design documents are approved
- Complete the technical specifications and designs to 100%
- QA program development
- QC responsibility
- Scheduling – Primavera
- Weekly meetings
- Purchase and installation of the radio system
- Testing
- Training
- Operations manuals
- Troubleshooting
- Contract modifications
- Warranty
- Extended warranty, if needed
- Daily inspection reports
- Full responsibility for designing and construction and cutover of new radio system.

6.3 Quality Assurance Elements

The QAP shall meet and align with the requirements of this contract and shall be designed and maintained such that the Contractor's work, including work performed by the Contractor's suppliers and Sub-Contractors, complies with statutory and regulatory requirements such as the applicable codes, special provisions, technical specifications and plans under the contract with respect to materials, workmanship, construction, installation, finish, functional performance, testing, commissioning and identification. Further, the QAP shall encompass all actions involving selection of construction/installation material sources and suppliers, on-site and off-site fabrication of Contractor-furnished products and services to be included in the work, on-site and off-site production of construction materials, inspection and acceptance of the SFMTA furnished materials, work placement procedures, workmanship, inspection, testing and commissioning.

Project personnel who have responsibility for ensuring or controlling quality shall be identified and interrelationships with project management defined. These relationships shall be shown on an organization chart. In particular, the personnel shall be identified who have responsibility to initiate and carry out actions to prevent quality problems, to identify and record quality problems, to implement solutions through appropriate channels, and to verify the effective implementation of these solutions to identified quality problems. Those personnel responsible for assuring quality must be independent of those having direct responsibility for the work being performed.

6.3.1 Management Responsibility

As part of their proposals, the Qualified Proposers shall provide evidence of the Qualified Proposers' team top management commitments to the development and implementation of the QAP by **[PRL 12-6-2 Top Management Commitment to Quality]:**

- Communicating to the respective organizations the importance of meeting SFMTA as well as statutory and regulatory requirements
- Ensuring that quality objectives are established
- Conducting management reviews, which includes documented reviews of the QAP quality policy at appropriate intervals to ensure that it remains suitable and effective, and
- Ensuring the availability of adequate resources to perform work on the project in compliance with project requirements and industry practices.

The Contractor's top management shall ensure that the SFMTA requirements are determined and are met with the aim of enhancing the SFMTA's satisfaction.

6.3.2 QAP Documentation

The Contractor shall establish and maintain a documented QAP to ensure project quality objectives are satisfied. The QAP provisions shall extend to the Contractor's suppliers and subcontractors, as appropriate.

Documented procedures and instructions shall be developed and established for activities affecting quality in design, development, procurement, manufacturing, and construction as applicable to the work performed. Procedures and instructions shall also be developed and documented for control of processes including inspection, testing, nondestructive examination, handling of nonconforming product, corrective action, maintenance of quality records, quality audits and surveillances, and training **[CDRL 12-6-2 Quality Procedures and Instructions]**.

The procedures shall contain statements of their purpose and scope, and shall contain any references to appropriate codes, standards, or specifications. In developing and documenting the quality procedures, consideration shall be given to identifying and acquiring any inspection equipment, skills, or special quality processes needed to ensure quality performance. Inspection and testing techniques shall be kept current and effective. The procedures and instructions shall contain formats for the quality records needed to ensure that the procedures and instructions are followed and documentation requirements are understood by all personnel performing work that affects the quality of the project products and services. Where new techniques are being used for construction, build or manufacturing, adequate time and resources shall be allocated for the development, verification and validation of appropriate quality procedures for the new techniques.

6.3.3 Design Control

The Contractor Design Manager shall establish, document and maintain procedures to control, verify and validate the design of the project deliverables in order to ensure that the design criteria, project requirements, and statutory and regulatory requirements are met. Design control includes

- Ensuring that the design requirements are understood,
- The planning and maintenance of system interfaces,
- Design verification and validation,
- and controlling design changes through project completion.

The Contractor Design Manager shall prepare a plan for design activities. The plan shall identify who has responsibility for the different design parts, and who has the responsibility for design oversight and design integration. It shall also identify the various organizational interfaces required between the groups producing and commenting on the design, and specify the information to be documented, transmitted, and regularly reviewed. Finally, the plan shall specify how the operation and maintenance departments of the SFMTA will interact with the Contractor's designers.

Design input requirements shall be identified, documented, and reviewed by the Contractor Design Manager. Ambiguity in the design input requirements or inadequacies of the design inputs shall be resolved between the Contractor Design Manager and the SFMTA.

Design outputs shall be documented. Design outputs shall meet the design input requirements, the project requirements, include acceptance criteria, conform to statutory and regulatory requirements whether or not these have been stated in the design input requirements, and identify those aspects of the design that are crucial to the safe and proper function of the final product or system. It shall be the Contractor Design Managers responsibility to ensure that:

- Reviews of design requirements for adequacy and the identification of ambiguities
- Verification of design outputs for meeting the design and development input requirements
- Validation of design outputs for meeting project requirements as well as statutory and regulatory requirements
- The competence of design personnel are evident.

Appropriate procedures shall be established and documented for the identification, documentation, review, and approval of all changes and modifications to the design. This responsibility shall extend to those responsible for construction, build or manufacturing to ensure design outputs meet the design input requirements, and for the development of "as-built" documentation as part of the design documentation at the end of the project.

6.3.4 Document Control

The Contractor shall identify processes and procedures for the Contractor's Document Control System. The requirements of this procedure apply to all project documents of internal and external origin, including:

- All project documents in electronic form (the preferred medium of storage)
- All versions of hardcopy submittals by the Design/Build Contractor
- Documents originating outside of the project (e.g. City and County of San Francisco, Federal Communications Commission, etc.).

A documented procedure shall be established to define the controls needed

- To approve documents for adequacy prior to issue
- To review and update as necessary and re-approve documents
- To ensure that changes and the current revision status of documents are identified
- To ensure that relevant versions of applicable documents are available at points of use
- To ensure that documents are issued and remain legible and readily identifiable
- To ensure that documents of external origin determined by the organization to be necessary for the project and the QAP are identified and their distribution controlled
- To prevent the unintended use of obsolete documents, and to apply suitable identification to them if they are retained for any purpose
- To ensure export controls and commitments to preserving the confidentiality of proprietary information and data are met, as agreed in the Contract and in accordance with statutory and regulatory requirements.

6.3.5 Purchasing

The Contractor shall ensure that all purchased products and services conform to project requirements and specifications. The Contractor shall qualify and select suppliers, subcontractors based on their capability to meet the requirements of the QAP, and establish warranty claim terms and conditions that conform to the requirements of the project. The Contractor shall be responsible for the conformance of supplier or subcontractor provided products and services with project requirements and statutory and regulatory requirements.

6.3.6 Product Identification and Traceability

The Contractor shall establish a set of documented and maintained procedures that describe methods used for the identification and the traceability of Contractor supplied products and materials, test equipments, tools, and equipment furnished by the SFMTA. Product identification and traceability is the primary responsibility of the Contractor.

The Contractor shall identify processes for the proper identification of products, control of material, items throughout all stages of production, handling, storage, shipment, delivery, installation, segregation, correction, repair, exchange and testing. This identification and control shall also be extended to include spare parts.

6.3.7 Process Control

The Contractor shall identify work processes executed by the Contractor, suppliers, and subcontractors that directly affect quality. This shall be conducted under controlled conditions through appropriate use of the following:

- Documented procedures defining the manner of production, installation, and servicing, where the absence of such procedures could adversely affect quality
- Use of suitable production, installation, and servicing equipment and a suitable working environment
- Compliance with reference standards and codes, quality plans, and/or documented procedures
- Monitoring and control of suitable process parameters and product characteristics
- The approval of processes and equipment, as appropriate
- Criteria for workmanship, which are stipulated in a clear and practical manner (e.g., documented standards, representative samples, or illustrations)
- Suitable maintenance of equipment to provide continuing process capability.

The Contractor Quality Manager shall be responsible that work processes and product characteristics are monitored through the use of surveillances, hold-point inspections, report reviews and or audits. The Contractor Quality Manager shall perform planned and systematic reviews and audits of processes and procedural compliance where results of processes cannot be fully verified by subsequent inspection and/ testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use.

The requirements for any qualification of process operations, including associated equipment and personnel, shall be specified as appropriate in specifications, procedures, and work procedures.

6.3.8 Inspection and Testing

The Contractor shall establish documented procedures that describe the process used to monitor and verify quality conformance for all material, equipment, software, and systems supplied for the project.

It shall be the responsibility of the Contractor Quality Manager to ensure that inspection and testing are in conformance of inspection and testing performed by contractors, suppliers, subcontractors and testing organizations throughout the duration of the project. This applies to all activities related to supervision or performance of project inspections and tests including receiving, in-process, and final inspection and testing.

When products are delivered to the Contractor, it shall be the responsibility of the Contractor's Quality Manager to ensure the verification of these products and their conformance with the project requirements and statutory and regulatory requirements. Verification shall be in accordance with the QAP and the procedures established for that purpose. The extent of receiving inspection can vary with the amount of inspection at the source, the safety criticality of the product, and the confidence in the quality procedures of the supplier.

In-process testing and inspection of the work to verify conformance of an item or work activity to specified requirements shall be in accordance with the QAP or documented procedures. Both inspection and process monitoring methods shall be performed, as necessary, to ensure that the specified requirements for the control of work processes and the quality of the item are being achieved throughout the duration of the work.

Final inspection and testing shall ensure that all specified inspections and tests, including those specified for receipt of product or in-process work, have been carried out and the resulting data meet specifications. Final inspection and testing shall be carried out and properly documented to ensure conformance of the finished product to the specifications.

Records shall be maintained of the various inspections and tests to provide evidence that the products have passed inspection and that the products have been tested with the defined acceptance criteria.

6.3.9 Inspection, Measuring, and Test Equipment

Inspection, measuring, and test equipment required to carry out inspection and testing shall be identified, controlled, calibrated, and maintained in order to demonstrate the conformance of work to the specified requirements. Provisions shall be made for recalibration of such equipment in a timely manner.

Inspection, measuring, and test equipment used shall meet the standards of accuracy for the measurements which are required. The equipment shall be calibrated according to national standards as applicable, and to documented standards where no national standards exist. The equipment shall be recalibrated at regular intervals, and the recalibration properly documented. A record of the equipment calibration status shall be maintained.

The equipment shall be properly maintained to ensure its fitness for use. When in use, the Contractor shall ensure that the environmental conditions are suitable for the use of the equipment. When inspection, measuring, or test equipment is found to be out of calibration, the validity of previous inspection and test results shall be assessed and documented by the Contractor Quality Manager.

6.3.10 Inspection and Test Status

It shall be the Contractor's responsibility to provide a means for identifying the inspection and test status of work during production and installation. The purpose of this is to ensure that only work that has passed the required inspections and tests is accepted. The test and inspection status shall be identified by means of markings, stamps, tags, labels, routing cards, inspections records, test software, physical location, or other suitable means. The status identification indicates the conformance or nonconformance with regards to inspections and tests performed.

The QAP shall include documented procedures to control inspection and test status so that only conforming items are identified as such, and used throughout the project.

6.3.11 Non-conformances

The Contractor shall establish documented procedures that describe the methods used to identify, segregate, correct and dispose of non-conforming items that are found during the execution the project.

The identification of non-conforming products or services shall be performed by any personnel of the project team. Reports of non-conforming products or services shall be verified by Contractor engineering staff, who issue a corresponding Corrective Action Request. It shall be the Contract Quality Manager's responsibility that non-conforming products or services are precluded from further use without proper authorization. Most commonly a method of "tagging" and/or segregating, shall be used if applicable. Segregation may not always be feasible due to size, configuration or installation location. In any regard, the process for identification of non-conforming products or services shall preclude its further use without proper authorization.

Non-conformances occurring inside a supplier's plant shall also be accountable to similar requirements and processes in accordance with the supplier's quality plan. Tracking and closure of non-conformances initiated in the supplier's plant shall be accomplished by that plant's QA team, but shall be auditable by the SFMTA and the SFMTA Quality Assurance Manager.

At a minimum, a nonconformance report, issued by the designated quality representative(s), shall document the following:

- Description of the condition adverse to quality,
- Approved disposition/instructions (i.e. reject, rework, repair, or accept as is),
- Corrections made or corrective actions taken, and
- Results of re-inspection after corrective work (if any) has been completed.

The decision to scrap, rework, reassign to alternative applications, or accept with or without repair (waiver to specified requirements) is made by the appropriate the SFMTA designated authority, e.g. the Resident Engineer, with the approval of the appropriate manager. A repaired or reworked product is re-inspected in accordance with documented procedures that are part of the QAP and subject to acceptance by the SFMTA.

All non-conformances shall remain in an open status until satisfactory corrective action has been implemented.

The Contractor Quality Manager shall monitor the Contractor's and suppliers' QC procedures for control, processing, and correct content of non-conformance reports and corrective action requests. Additionally, the Contractor Quality Manager shall capture system wide defects and their defect rates, and prepare trend reports identifying patterns of non-conforming products or services, with association to design consultants, suppliers, Contractors, and subcontractors for the Quarterly Quality Management Review Meeting.

6.3.12 Corrective Action

The Contractor shall establish documented procedures for the investigation of the root cause of nonconforming work or products, and the corrective action needed to prevent recurrence, and procedures for analysis to detect and eliminate potential causes of nonconforming work. This element also includes implementing and recording changes in procedures resulting from corrective action. The Contractor Quality Manager shall be responsible for the effective implementation of corrective actions.

6.3.13 Quality Records

The Contractor shall establish documented procedures that identify, collect, index, access, file, store, maintain, and dispose of quality records. The procedure shall be consistent with the SFMTA criteria for the handling of quality records. Quality records shall be maintained to provide evidence for the achievement of quality objectives and the performance of the QAP. Supplier, contractor, and subcontractor quality records shall be included as needed. Quality records shall be legible and shall specify the work involved. They shall be kept in an environment to minimize deterioration and damage. Retention times and final disposition shall be established and recorded. Where specified by the Contract, quality records shall be made available to the SFMTA.

6.3.14 Quality Audits and Surveillance

Quality surveillances and audits shall be conducted to ensure that the elements of the quality management system are functioning as required and intended. A QA Program shall be established to steer audits and surveillances.

As part of the QA Program, an audit schedule shall be developed, taking into consideration the status and importance of the processes and areas to be audited as they relate to the project schedule and the progress of project execution, as well as the results of previous audits and surveillances and the management reviews. The audit criteria, scope, frequency and methods shall be defined prior to an audit or surveillance.

The management responsible for the audited area shall ensure that any necessary corrections and corrective actions are taken without undue delay to eliminate detected non-conformances and their root causes. Follow-up activities shall include verification of the effectiveness of the actions taken, and the reporting of verification results.

6.3.15 Training

The Contractor shall establish, document and maintain procedures for identifying the training needs and provide for the training of all personnel performing activities affecting the quality of products and services. All personnel performing activities affecting quality shall be qualified and evidence shall be provided that show the competence of personnel on the basis of appropriate education, training, and/or experience, as required. Appropriate training and qualification records shall be maintained.

6.4 Quality Control and Inspection

This section specifies the Quality Assurance/Quality Control and Inspection (QA/QC&I) requirements for the work that shall be performed on the MTMS and PSVRN project. These requirements shall encompass all actions involving the selection of material sources and suppliers, inspection and testing of materials, work placement procedures, workmanship, equipment calibration, use of Certificates of Compliance, implementation of procedures for audit, surveillance and corrective action, inspection, testing and commissioning.

The Contractor shall permit the SFMTA staff or its representatives access to the contractor's facilities while system manufacturing and testing are taking place and to any facility where hardware or software is being produced for the project.

The SFMTA will perform inspections that include visual examination of hardware, cables, and equipment. The documentation and quality records produced by the Contractor may also be examined to verify that it adequately identifies and describes all hardware and software.

Inspection rights shall expand to subcontractors that are developing new hardware or software for inclusion in the project.

6.5 Quality Control (QA/QC) and Inspection Plan/Quality Assurance

6.5.1 Standards

It shall be the responsibility of the Contractor to provide and maintain a Contract Quality Assurance/Quality Control (QC/CQA) and Inspection Plan for all work performed under the contract. This requirement is independent of any acceptance inspection and testing performed by the SFMTA and /or testing and certification organizations. Within sixty (60) days after the issuance of the NTP, the Contractor shall submit a QC/CQA and Inspection Plan to the SFMTA for acceptance **[CDRL 12- 6-3 QC/CQA and Inspection Plan]** . The plan shall cover all work to be performed under the contract. Acceptance of the Contractor's CQA/QC and Inspection Plan shall not relieve the contractor of responsibility to comply with the contract requirements as well as statutory and regulatory requirements.

The QC/CQA and Inspection Plan shall be designed and administered to assure that the Contractor's work, including work performed by the Contractor's suppliers and Subcontractors, shall be in compliance with the latest version of applicable codes, special provisions, technical specifications and plans under the contract with respect to materials, workmanship, construction, installation, finish, functional performance, testing, commissioning and identification. The CQA/QC and Inspection Plan shall encompass all actions involving selection of production, configuration, installation material sources and suppliers, on-site and off-site fabrication of Contractor-furnished items to be included in the work, on-site and off-site production of construction materials, inspection and acceptance of the SFMTA furnished materials, work placement procedures, workmanship, inspection, testing, and commissioning.

The Contractor's CQA/QC and Inspection Plan shall include as a minimum the following:

1. An organization chart showing the Contractor's project organization that shows personnel that is involved with the project in a function that affects product or service quality.
2. The Contractor's on-site organization chart including a QC organization showing the proposed quality management and CQC Staff.
3. A description of the authority, duties and responsibilities of the QC personnel.
4. A management "Statement of Commitment" of direction to the Contractor's representative and CQC staff, which defines their duties, responsibilities, and authorities, shall be provided to the SFMTA.
5. Documented procedures for accomplishing and reviewing work, supervision, inspection, tests, certifications, documentation of QC activities, including those of Subcontractors for all work under the contract.
6. Documented procedures for QC training.
7. The coordinating procedures and authorities concerning the work activities performed and not under the direct supervision of quality management.

The Contractor's detailed CQA/QC and Inspection Plan submission shall include the following:

1. A detailed schedule/matrix of control testing and inspection keyed to the individual Special Provisions and Technical Provisions of the Contract and covering each item of the work the SFMTA shall approve the format of the test matrix. The test and inspection schedule shall cover all work to be performed under the contract, including both on-site and off-site fabrication. Inspection and test records shall include, but shall not be limited to, the factual evidence that tests have been conducted, expected test reaults, the applicable type and number of tests, the dates and results of the tests, nature and number of observations made, the number and type of deficiencies found and proposed corrective actions to be taken. All records shall provide identification and signature of the individual in charge of the inspection, test, or other QC activity. These records shall be certified by the CQC manager and include, as a minimum, the results of:

    - Inspection results, observations, conclusions and recommendations
    - Testing with reference to set-up conditions, observations and concerns
    - Fabrication procedures and controls
    - Identity of the personnel present and their certification
    - Discrepant material details (including disposition records). The legible copies of these records must be furnished to the SFMTA daily. The records shall cover all work performed subsequent to the previously furnished records and shall be verified by the Contractor Quality Manager.

A minimum of three (3) phases of inspection to be performed by the CQC staff for all definable items of work. The phases are:

1. **Preparatory inspections** shall be performed prior to beginning of each item of work and shall include a review of contract requirements and CQA/QC and Inspection Plan test and inspection schedule as defined in **Appendix Twelve (12) Section Seven (7): "**Testing and System Acceptance". Preparatory inspections shall include a physical examination of materials and equipment to verify the conformance to approved shop drawings or submittal data and that materials and equipment are present in the required quantities to proceed with the work.
2. **Initial inspections** shall be performed as soon as a representative portion of the work has been accomplished. Initial inspections shall verify the conformance with contract requirements and statutory and regulatory requirements, establish acceptable levels of quality and workmanship, review quality control testing and confirm that defective, damaged or unapproved materials are not incorporated into the work.
3. **Follow-up inspections** shall be performed regularly by CQC staff to ensure continued conformance with the contract requirements and statutory and regulatory requirements at established levels of quality and workmanship.

The SFMTA shall be notified at least forty-eight (48) hours in advance of each preparatory and initial phase inspection. Additionally, the Contractor Quality Manager shall ensure that all phases of inspection are made a matter of record in the CQA/QC and Inspection Plan documentation.

The CQA/QC and Inspection Plan shall provide well-defined procedures and forms to include, but not limited to the following:

- Identifying and evaluating quality-related problems
- Recommending solutions to quality-related problems and verifying that those problems are resolved
- Controlling further fabrication, delivery, or installation of nonconforming or deficient item(s) until disposition instructions have been obtained
- Conducting quality inspections, surveillance and compliance audits of all subcontractors and suppliers/manufacturers on a scheduled and unscheduled basis
- Maintaining quality control reports, approved shop drawings and submittals, as-built drawings, changes to the drawings and specifications.

The CQA/QC and Inspection Plan shall also provide documented procedures to include, but not be limited to:

- Control of subcontractors, manufacturers /suppliers
- Production and process quality control
- Discrepant and nonconforming material control
- Functional testing
- Calibration and/or certification of measuring and test equipment
- Shipping and receiving inspection of materials.

6.5.2 Inspection, Measuring, and Test Equipment

It shall be the responsibility of the Contractor to ensure that equipment capabilities and measurement uncertainty is known and is consistent with the required measurement capability. Contractor Quality Manager shall be responsible for the monitoring of the Contractor's, subcontractor and supplier's control, calibration, and maintenance of inspection, measuring, and test equipment used throughout the project.

The CQA/QC and Inspection Plan shall include procedures that describe the management and control of inspection, measuring, and test equipment (including test software) used to demonstrate the conformance of products and services to the specified requirements for throughout the duration of the project.

Inspection and Measuring shall be applied, but not limited, to the following aspects of the MTMS and PSVRN:

1. Signal interference (adjacent, co-channel, and intermodulation interference)
2. Signal coverage/simulcast coverage (single and multiple sites
3. Audio Quality (voice reception, clarity, etc.)
4. Data system performance, including bit-error-rates and polling rate
5. Air-time traffic capacity
6. System throughput
7. Interface compatibility with other sub-systems
8. Interoperability with other communication systems.

The Contractor shall establish a documented procedure for identifying, controlling, calibrating, and maintaining all inspection, measuring, and test equipment to be used on the project. The Contractor's process shall include the following components:

- Certification to traceable reference standards
- Maintenance of records and labeling
- Frequency of calibration
- Disposition of Non-Conforming IM&TE.

6.5.3 Source of Materials

As part of their proposals, the Qualified Proposers shall identify sources of all products and services from which the Contractor proposes to obtain material requiring approval, certification, or testing indicating details and characteristics. These shall not be changed without written approval by the SFMTA.

6.5.4 Calibration and Certification

The CQA/QC and Inspection Plan shall include the procedures to provide and maintain gauges; measuring devices and test equipment necessary to assure that the article or device conforms to contract requirements. These devices shall be calibrated in accordance with national standards and certifications calibration certificates shall be maintained current and submitted to the SFMTA. Any equipment exceeding its required re-calibration date or that becomes damaged or otherwise unreliable, shall handled through the procedure for non-confirming product.

6.5.5 Manufacturing Control

The CQA/QC and Inspection Plan shall include methods for ensuring that all machining, wiring, shaping, and all other basic processing, fabrication and production operations of any type are accomplished under controlled conditions, including documented work instructions, certified personnel, adequate production equipment, and any special working environment.

6.5.6 Inspection & Test Status

The CQA/QC and Inspection Plan shall include methods for ensuring that all required inspections and tests are performed according to **Appendix Twelve (12) Section Seven (7): "Testing and System Acceptance"** and that the status of each work product, material items inspections/tests is known. The Contractor shall identify non-conforming work product and material items by physical segregation and status indicators such as tags, markings, serialization, stamps, and/or inspection records. The identification system used shall ensure that only those work items that have passed inspection shall be used, shipped, or installed, The nonconforming work product and material items shall be removed from the project site and storage areas.

Work products, materials and/or equipment manufactured or assembled under this contract shall be accepted for use or released for shipment, as appropriate, when the following conditions(s) have been met:

- After inspection and/or release by the SFMTA and/or certification by the Contractor that the work product or material item is complete and in compliance with the contract specifications.
- Upon request for acceptance or a release for shipment submitted by the Contractor and supported by a satisfactory inspection report or certification of compliance accompanied by certified copies of test data. The certificate of compliance shall clearly identify the work product or material item covered by the certificate and shall also contain the test date and the name and address of the organization performing the require tests, as applicable.
- Supplies, services, materials, and products procured from suppliers and subcontractors shall conform to the contract requirements and the approved CQA/QC and Inspection Plan. Inspect all supplies, materials, services, and products upon receipt.

6.5.7 Non-Conforming Items

The Contractor Quality Manager shall take prompt action to correct conditions that have resulted or may result in non-conforming products, parts, components, installations, or functions/operations. The Contractor Quality Manager shall document the non-conforming work and efforts to correct the deficiencies and prevent its occurrence in the future, the CQA/QC and Inspection Plan shall provide for:

- Maintaining an effective and positive system for controlling non-conforming work product and material item(s) including procedures for identification, segregation, removal and disposition. The Contractors shall document the corrective actions and submit to the SFMTA for acceptance.
- Ensuring that all non-conforming items(s) shall be positively identified to prevent unauthorized use, shipment, or intermingling with conforming items. Disposition for the use or repair of non-conforming items shall require the SFMTA's acceptance.

If the Contractor's work does not conform to the requirements of the contract, the SFMTA may issue a "Corrective Action" or "Non-conformance Report" to the Contractor. The Contractor shall correct all deficiencies or otherwise respond to the report within ten (10) days of issuance of report by the SFMTA. The Contractor shall not build or conceal any feature of the work containing uncorrected defects.

6.5.8 Handling and Storage

The CQA/QC and Inspection Plan shall ensure that proper instructions are provided and followed for handling, storage, preservation, packaging, and shipping to protect the quality of products and to prevent damage, loss, deterioration, degradation, or substitution of products. Means shall be provided for any necessary protection against deterioration or damage to products/equipments in storage and handling.

6.5.9 Unacceptable Work Products and Material Items

Work products or materials represented by installations or samples taken and tested in accordance with the specified test and failing to meet required values shall be considered to be defective regardless of prior tests or approvals.

Unless otherwise allowed by the SFMTA, as set forth below, defective work products or material items shall be removed from the site. Where defects can be corrected, the Contractor may propose corrective action in accordance with the manufacturer's recommendation or by other means as is deemed appropriate by the SFMTA. The SFMTA may approve the corrective action but does not assume responsibility for the success thereof. Re-inspection and/or re-test may be made to determine acceptability of the material after corrective measures have been taken.

6.6 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

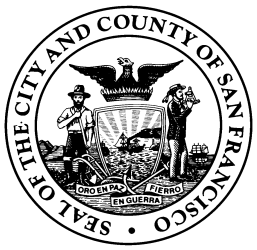
- PRL 12-6-1 PRL 6-1 Sample Quality Assurance Program Plan
- PRL 12-6-2 Top Management Commitment to Quality.

6.7 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-6-1 Quality Assurance Plan with QA Program
- CDRL 12-6-2 Quality Procedures and Instructions
- CDRL 12- 6-3 QC/CQA and Inspection Plan.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **seven**

Testing & System Acceptance

Revision History

Revision	Date	Change	Approval
0	11/25/2009	Release for RFQ/RFP	n/a

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7.0 Testing & System Acceptance

This section shall apply to all equipment provided as part of the integrated Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS).

All materials furnished and all work performed under Contract 1240 shall be tested as specified following.

In general, deliverables shall not be submitted until all required tests have been completed, all deficiencies have been corrected to the SFMTA's satisfaction, and the hardware and software has been approved for submission by the SFMTA.

Should any tests indicate that specific hardware, software, or documentation does not meet these Specification Requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor, at the Contractor's expense, as necessary to correct the noted deficiencies. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test program shall be considered successfully complete only when:

- All tests have been performed
- All variances have been resolved to the satisfaction of the SFMTA
- All test records and reports have been submitted to the SFMTA and have been approved
- SFMTA acknowledges, in writing, successful completion of all testing.

System Acceptance shall only occur after successful completion of the System Availability Test and other requirements and criteria as specified in this section.

7.1 Test Plans & Procedures

Test plans and test procedures for all tests shall be provided by the Contractor to ensure that each test is comprehensive and verifies all the features of the functions to be tested. During the development of test plans and test procedures for application software, firmware, and hardware, special emphasis shall be placed on comprehensively testing of each function and feature. The test procedures shall be modular to allow individual test segments to be repeated as needed.

For each factory and field test, test plans and test procedures shall provide a high level functional summary. Test procedures shall provide the step-by-step activities associated with each test.

All test plans and test procedures shall be submitted to the SFMTA for review and approval and shall also be subject to the approval process as defined in the Contractor's Quality Assurance Plan.

7.2 Integrated System Test Plan

The Integrated System Test Plan (ISTP) must be approved by the SFMTA prior to the start of any testing **[CDRL 12-7-1 Integrated System Test Plan]** . There shall be one ISTP, made up of individual subsystem test plans as required. The following information shall be included in the ISTP:

- Test schedule
- Vehicle and facility access requirements, and resource constraints
- Record-keeping procedures and forms
- Procedures for monitoring, correcting, and retesting variances
- Procedures for controlling and documenting any and all changes made to any system or subsystem after the start of testing
- Block diagram and general descriptions of the hardware test configurations, including Contractor and the SFMTA supplied equipment, radio equipment, revenue and non-revenue vehicle equipment, external communications equipment, and any test or simulation hardware
- A list of all individual tests to be performed and the purpose of each test segment
- Provisions for testing of the SFMTA-defined operational scenarios
- Provisions for independent testing by the SFMTA to exercise the features of the installed system
- Identification of all special hardware, software, tools and test equipment to be used during testing
- Techniques and scenarios to be used to simulate ultimate system sizing, processor utilization, and performance, especially during the peak loading test
- Copies of any certified test data (e. g. environmental data) to be used in lieu of testing
- Example forms for test reports and test failure reports.

7.3 Test Procedures

All test procedures shall be submitted to the SFMTA for approval that are based upon, and consistent with, the approved ISTP **[CDRL 12-7-2 Test Procedures]**. Test procedures shall be submitted to the SFMTA for approval only after the ISTP has been approved by the SFMTA. Fully approved test procedures are required prior to the commencement of the respective testing. Testing shall not commence without approved test procedures. The SFMTA will only approve test procedures if they are inclusive and thoroughly test each purchased system component, both independently and collectively. All test procedures shall include the following items:

- Function or feature to be tested
- Purpose of each test segment
- Set-up and conditions for testing
- List of procedures to be followed
- All input and test equipment settings
- Expected results for each test segment
- Pass/Fail acceptance criteria for each test segment
- Descriptions of all simulation tools and techniques used during the test.

7.4 Test Records

Complete records of all test results shall be maintained by the Contractor and made available for inspection by the SFMTA or its representative(s) at any time **[CDRL 12-7-3 Test Records]**. In accordance with the Contractor's Quality Assurance Program, the following items shall be included in the test records:

- Reference to the appropriate test procedure
- Test results for each test segment, including a passed/failed indication and any modifications made to the procedures or test setup during the test
- Identification of the Contractor's test engineer and of the SFMTA's representative(s) witnessing the test
- Date and time of the test
- Provision for comments by the SFMTA's representative(s)
- Copies of any variance reports generated
- System documentation including logs, files, configuration description, measurement records, or printouts saved as part of the test.

7.5 Reporting of Test Variances

A Test Variance Report shall be prepared by the Contractor and witnessed/concurred by the SFMTA personnel each time a deviation from specified requirements, test procedures, or the Contractor's design is detected during any formal or informal, factory or field testing, between the start of factory testing and through to final acceptance of the complete system (combined PSVRN and MTMS) **[CDRL 12-7-4 Test Variance Reports]**. In accordance with the Contractor's Quality Assurance Program, the Test Variance Report shall include
a complete description of the variance, including the following items:

- A sequential identifying number assigned to the variance
- The date and time the variance was first discovered
- Variance classification (Class 1, 2, or 3)
- Variance status (open, closed, etc.)
- Appropriate references to the test procedures, technical specifications, or design documentation
- A description of the test conditions at the time the variance was detected
- Identification of Contractor and the SFMTA witnesses
- A sign-off by both the Contractor and the SFMTA when the correction of the variance has been verified.

Each variance shall be assigned to one of the following three classes, depending on its severity and impact on the testing and the system. Variances will be classified by the Contractor with the SFMTA having approval rights:

Class 1 Severe variance that prevents, invalidates, or significantly impairs further testing. Testing will stop for immediate evaluation and correction by the Contractor.

Class 2 Significant variance. Testing will continue and the variance will be corrected by the end of the current session or day.

Class 3 Isolated variance that does not impact or invalidate other testing. Testing will continue and the variance will be corrected and tested at a mutually agreed upon time (e. g. at the end of the test, or later in the test period prior to shipment).

7.6 Disposition of Test Variances

The Contractor shall document all actions taken to correct variances. Sufficient information shall be provided in the variance documentation to enable an SFMTA representative to determine the need for retesting the function, for testing interaction with any previously tested function, and for updating appropriate documentation as a result of the corrective action. Variance corrections that would result in a change to an approved document or configuration changes must be approved by the SFMTA prior to implementation by the Contractor.

Variance reports shall be closed when authorized Contractor and the SFMTA representatives acknowledge, by signatures, correction of the variance. The Contractor shall propose a means to securely enable variance documentation, summaries, and reports to be accessible via the Internet by the SFMTA or its representatives.

The Contractor shall maintain a variance summary that lists the following for each variance:

- Variance number
- A brief description of the variance
- Date generated
- Test procedure reference
- Variance class
- Current status
- Date the variance was closed
- A brief description of the resolution of the variance.

The current variance summary shall be published by the Contractor at the completion of each phase of testing, just before a new phase of testing, and/or whenever requested by the SFMTA **[CDRL 12-7-5 Test Variance Summary]**.

7.7 Factory Testing

The following types of tests, as discussed below, shall occur as part of factory testing at the Contractor's and subcontractors' facilities:

- Component/device/module testing
- Individual sub-system testing
- Sub-system integration testing.

The following conditions must be satisfied prior to the start of the factory tests:

- All applicable hardware and software engineering design changes shall be incorporated into the PSVRN and MTMS
- PSVRN and MTMS documentation, including drawings, list of deliverables, software functional documents, factory test plans and test procedures, and user manuals shall have been reviewed and approved by the SFMTA
- All action items related to approval documents, system performance, and test simulation techniques shall be resolved.

All testing hardware, software, and special test and calibration equipment required to demonstrate the acceptable operation of the PSVRN and MTMS, including radio communications with the on-board vehicle equipment, communications control features, and simulation of system loading shall be provided by the Contractor. Equipment shall not be substituted by the Contractor during factory tests without prior the SFMTA authorization.

Factory testing shall consist of a Contractor-performed dry run of the factory tests, formal factory testing, and unstructured and/or ad-hoc testing by the SFMTA, its representative(s), or the Contractor.

Written certification that the dry run testing has been successfully completed shall be provided to the SFMTA prior to the start of formal factory testing. All variances that would preclude testing all, or portions of, the formal factory testing shall be corrected by the Contractor prior to the start of formal testing. The SFMTA or its representative(s) shall have the right to review the variances with the Contractor and to determine which variances must be fixed prior to the start of the formal factory testing. The Contractor shall provide the SFMTA with copies of all variances found during the dry run testing.

All radio communications systems tests shall be performed using mobile antennas "over-the-air".

For radio communications systems factory testing at the LMR Contractor's facility, all equipment to be provided shall be included in the test configuration.

As part of MTMS testing, an abbreviated suite of equipment shall be provided but must still include, as a minimum, two trunked voice radio communications channels, one trunking control channel, and two (2) data channels. Testing shall include demonstration of trunked voice and data channel operations.

The factory testing shall include simulation of all AVL functions by equipping a Contractor-supplied test vehicle with a full set of the Contractor-provided revenue vehicle equipment. Both structured and unstructured testing shall be performed using the test vehicle.

The factory tests shall be considered successfully complete only when all tests have been performed, all variances have been resolved to the satisfaction of the SFMTA, all test records have been issued to the SFMTA, the SFMTA approval of all test reports, and the SFMTA acknowledges, in writing, successful completion of the factory testing and authorization to ship the PSVRN and MTMS to the SFMTA.

7.8 Unstructured Testing

Periods of unstructured testing shall be permitted during the course of the functional testing to allow the SFMTA representatives to verify the proper operation of the PSVRN and MTSM under conditions not specifically included in the approved test procedures. Unstructured testing of specific functions, features, or operations may be conducted during the course of the structured testing where the unstructured testing does not impact the structured testing. Unstructured testing also shall be allowed at the SFMTA's discretion, both at the end of a structured test segment and after the completion of the functional performance testing. At least one hour of each testing day and up to eight (8z0hours at the end of each test segment (e.g. Radio Coverage Acceptance Test, Mini-Fleet Test, Field Performance Test, etc.) shall be designated for unstructured test time. During unstructured tests, the Contractor’s test representatives shall be present and available for consultation with the SFMTA representatives. All simulation software and hardware, and other test facilities used during the structured portions of the testing shall be made available for the SFMTA’s use during unstructured testing. Unstructured testing can result in variances that must be corrected by the Contractor.

7.9 Integrated System Test Program

The Integrated System Test Program shall consist of the phases listed below, performed in the following order:

1. Component, Device, and Module Testing
2. Individual Subsystem Testing
3. Subsystem Integration Testing
4. Radio Coverage Acceptance Test
5. Field Performance Test
6. Mini-Fleet Test
7. System Availability Test.

7.9.1 Component, Device, and Module Testing

Component, device, and module testing shall include all individual hardware, software and firmware components. As a minimum, testing shall apply to the following equipment:

Fixed Equipment:

- Computer servers – both general and special purpose
- Computer storage equipment – Storage Area Networks (SAN), etc.
- Computer workstations
- Dispatch consoles and other furniture
- Radio Equipment – transmitters, receivers, site controllers
- GPS time base clock
- GPS receivers
- GPS reference station
- Audio switching equipment
- Monitors, keyboards, printers and other computer peripherals
- Antenna and feed-line equipment – antennae, combiners, multi-couplers, isolators, surge protectors, bi-directional amplifiers, etc.
- Wire and cable
- Equipment racks and enclosures, ladder racks, etc.
- Headsets and footswitches
- Connectors, brackets, braces, other miscellaneous hardware
- Power supplies including uninterruptible power supplies
- Network equipment – switches, routers, wireless access points, media converters, etc.
- Passenger Information signs - Indoor or outdoor LED and LCD displays, sign controllers, etc.
- Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) System
- Digital trunked radio communications system
- Network management system
- Passenger Information System
- All software modules.

Mobile Equipment:

- Mobile Data Terminals (MDT)
- Laptop computers and mounting brackets
- Vehicle Logic Unit (VLU)
- Electronic display signs
- Wire and cable, terminal blocks, and interfaces
- Equipment racks and enclosures
- Brackets and braces
- Power supplies
- Antennas
- GPS receiver
- Radio – mobile transmitters, receivers
- Telephone handset
- Handheld and covert microphones
- PA amplifier and speakers
- Switches
- Wireless Local Area Network (WLAN) equipment, air-cards, etc.
- All software modules.

Portable Equipment

- Portable radios
- Batteries
- Accessories – microphones, holsters, antennas, etc.
- All software modules.

7.9.2 Individual Subsystem Testing

Individual subsystem testing shall include all contractor-defined groups of equipment classified as subsystems. The subsystems shall include but not be limited to the PSVRN, MTMS, including all base Intelligent Transportation System components, and any purchased optional equipment. Testing shall include hardware functional tests and tests to verify that all software functional requirements defined in **Appendix Twelve (12) "Technical Specifications"** and in Contractor (and Sub-Contractor) provided documentation have been met.

7.9.3 Subsystem Integration Testing

As a minimum, subsystem integration tests shall be performed between the following in a factory environment (i.e. not at the SFMTA):

- Individual components of the PSVRN
- Individual components of the MTMS
- The PSVRN integrated with the MTMS (base and optional components).

Sub-system integration testing may be permitted or progress at the SFMTA sites and facilities upon approval, and/or in cases where SFMTA provided equipment is to be integrated with Contractor's equipment.

Sub-system integration testing shall verify that all features and functions of the integrated PSVRN and MTMS have been properly designed and implemented. The SFMTA staff or representatives shall witness and participate in sub-system integration testing of a fully integrated PSVRN and MTMS, conducted at the Contractor's facility prior to shipment. The following items, at a minimum, shall be tested:

- Operation of all features, modes, devices, hardware, software, firmware, and interfaces
- Testing of all voice and data channel features, network control, network management system, and fault/diagnostic monitoring
- Testing of all revenue and non-revenue vehicle functions using actual vehicle radios and equipment
- Testing of AVL functions using a mobile test vehicle and base map
- Verification of all data transfers to and from the MTMS
- Testing of all applications, user interfaces and dialog screens
- Testing of all on-board equipment interfaces, data transfers, and dialog screens
- Testing of all emergency alarm features including monitoring of covert audio
- Simulation of failures and abnormal operating conditions
- Simulation of hardware failures and failover for PSVRN and MTMS components that have backups, are clustered, are distributed, or are redundant
- Verification that spare memory capacity and processor loading requirements have been met
- Verification of device and system recovery from AC and DC power supply failures, over-voltage, and under-voltage
- Verification of accuracy of hardware and software documentation via random checks.

If the SFMTA representatives believe the quantity and/or severity of the PSVRN and/or MTMS variances warrant a restart of any test, the test shall be halted, remedial work shall be performed, and the complete test shall be rerun at a time agreed upon between the Contractor and the SFMTA.

Travel expenses for the SFMTA staff and its representatives shall be reimbursed due to test delays based on severe variances. This shall apply to delays extending beyond one night during a trip or if testing must be stopped and resumed at a later date. Travel expenses shall include hotel, meals, airfare, and ground transportation.

7.9.4 Radio Coverage Acceptance Test

Radio Coverage Verification Tests

The coverage verification tests are to be performed under full foliage conditions, preferably in the Spring and Summer months.

The preliminary tile or grid maps and associated coverage acceptance field test plan shall be submitted by the Contractor within ninety (90) calendar days after the notice to proceed is supplied by the SFMTA. The SFMTA must be included in the process of selecting test tiles or grids prior to mutually agreeing to the tests.

The SFMTA will submit any deletions or additions that must be included in the Coverage Acceptance Test Plan within thirty (30) calendar days after receiving the preliminary coverage test plan. The final test plan, as well as all grid or tile maps, is considered part of the Final Design Review. This submittal shall incorporate all agreed-upon revisions, as well as those related to the changes made in the final network design. Completion of Final Design Review shall be contingent upon on an approved Coverage Acceptance Test Plan **[CDRL 12-7-6 Coverage Acceptance Test Plan]**.

The Qualified Proposer shall submit a sample Coverage Acceptance Test Plan as part of their proposal **[PRL 12-7-1 Sample Coverage Acceptance Test Plan]**. A example plan is included in **Appendix Seventeen (17)**. The Qualified Proposer's Sample Coverage Acceptance Test Plan shall be finalized to become the Draft Coverage Acceptance Test Plan, which will become part of the Contract 1240 documents.

The final Coverage Acceptance Test Plan is subject to approval of the SFMTA. Any testing conducted prior to final approval will not be considered valid.

The approach to selecting actual drive routes shall be described and shown on an appropriate map, suitable for use during the test. Test routes and the test evaluation shall emphasize roadways utilized by the SFMTA.

If the system is completed so that coverage testing would take place without full foliage conditions, the Contractor shall propose either to:

- Postpone full system acceptance until testing can be done under full foliage conditions; or
- Test without full foliage, but factoring in agreed-on attenuation factors as degradation of the test results to account for foliage.

If the latter is proposed, the Contractor shall describe in detail how his obligations to fulfill all specification requirements, including coverage reliability, will be met after testing has taken place.

Testing shall be done in both talk-in and talk-out directions. Coverage requirements require that each direction pass the criteria specified, for each device specified (mobile and portable).

The SFMTA staff shall be permitted to participate and/or witness all tests.

For Delivered Audio Quality (DAQ) tests, personnel from the SFMTA and the Contractor will be present to rate the quality of the transmission. The rating will be on a DAQ basis of 0 to 5 as defined in TSB-88, using the phonetically balanced Harvard Sentences.

There are three (3) categories of voice system tests to be performed:

1. Site-Specific Tests for the specific locations listed below:
    - Maintenance Facilities
    - Tunnels (above ground and below ground)
    - SFMTA platforms and ticketing areas (underground and above-ground)
    - SFMTA underground subway service rooms
    - Subterranean areas (Cable Car Machinery).
2. Mobile coverage throughout the Service Area
3. Portable coverage throughout the Service Area

For site specific maintenance facilities, DAQ tests will be made at randomly selected outdoor locations with a portable radio operator walking. A minimum of 50 measurements will be taken per bus yard. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration. Tests at each location shall meet or exceed coverage requirements specified herein for portable radios.

For site specific tunnels, DAQ tests will be made at randomly selected spots with a portable radio operator standing in a moving subway vehicle. The number of test measurements will be established later. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration. Tests at each location shall meet or exceed coverage requirements specified herein for portable radios.

For site specific tunnels, signal strength and Bit Error Rate (BER) measurements shall be made along all underground track-ways at randomly selected track-way locations using the subway vehicle antenna. The number of test measurements will be established later. Tests in each tunnel shall meet or exceed the requirements specified herein for vehicular radios.

For site specific platforms and ticketing areas, DAQ tests will be made at randomly selected spots with a portable radio operator walking. A minimum of 25 measurements will be taken per station platform and per ticketing area (each). The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration.

Tests at each platform and at each ticketing area shall meet or exceed coverage requirements specified herein for portable radios.

For site specific underground subway service rooms and subterranean areas (Cable Car Machinery), DAQ tests will be made at randomly selected positions at each location with a portable radio operator standing. A minimum of three (3) measurements will be taken per location. The hand held radio will be positioned in a swivel hip-mounted holder. The radio will be tested with the use of a speaker/microphone as part of the test equipment configuration. All tests combined shall meet or exceed coverage requirements specified herein for Cable Car Machinery portable radios. In addition, two out of three measurements at each area shall meet or exceed applicable DAQ requirements.

Mobile Service Area measurements (signal strength, BER and Message Success Rate), and portable Service Area measurements (signal strength, BER) will be performed by traveling throughout the service area. The objective in selecting the routes will be to select test locations that are randomly and evenly located within the service area, and are representative of actual use conditions. This shall be achieved by dividing the service area into grids as described below. Sampling rates within each grid shall confirm to TSB-88 requirements. Resulting measured data shall be median values.

The minimum number of tiles or grids for the mobile and portable signal strength and BER Service Area measurements shall follow. Inaccessible tiles shall be excluded from measurements and calculations. Tile count is based on the following:

- 95% Required Service Area Reliability
- 99% Confidence Level
- 1.0% Sampling Error Allowance.

Mobile radio coverage tests shall prove to the satisfaction of the SFMTA representatives that the radio system provides reliable communications coverage and performance for two-way voice and data transmission for mobile radios at all outdoor locations throughout the required Service Area previously defined. The mobile radio coverage tests to be performed by the Contractor shall consist of received RF signal level measurements throughout the required Service Area and DAQ.

The tests shall commence after the radio equipment is installed and tested at all of the SFMTA sites. The procedures to be followed during the Radio System Coverage Acceptance Tests shall be developed by the Contractor and submitted to the SFMTA for approval as part of the factory and field test plan and procedure documents.

Voice System Coverage Test Failure

A mobile or portable coverage test shall be considered to have failed if it fails to score as required (both in the site-specific and Service Area tests).

Following failure of a coverage test, the contractor shall take corrective action. This action shall be at no cost to the SFMTA, either for the corrections or for re-testing to verify adequacy of the corrections.

If system design configuration changes or modifications are made to correct inadequate performance, all associated tests that were conducted in areas affected by the change will be repeated.

For the purposes of this test, the Contractor shall have the responsibility to provide the test vehicles and drivers.

At the conclusion of this activity, the Contractor shall present to the SFMTA written certification that the tests performed were in accordance with the approved plan, and that the results in reference to corrective action, have resulted in the passing of the prior failed test locations.

7.9.5 Field Performance Test

The Field Performance Test shall include an integrated PSVRN and MTMS with all purchased options, as installed at the SFMTA.

The Field Performance Test shall be conducted after the integrated PSVRN and MTMS is installed at all of the SFMTA's sites AND successful completion of the Radio Coverage Acceptance Test. The purpose of this testing will be to ensure that the integrated PSVRN and MTMS, as installed in the field and on a single revenue vehicle, works properly as a fully integrated and installed system.

This testing shall encompass the full range of PSVRN and MTMS functionality including all Options purchased and areas of operation that were simulated or only partially tested in the factory and areas where variances were found during factory testing. The SFMTA shall provide on-site support during this test to assist in the testing and to help identify variances. All test variances must be corrected prior to the start of the Field Performance Test. At the successful completion of the Field Performance Test, the radio coverage acceptance tests, and the correction of any resulting variances, the integrated PSVRN and MTMS shall be ready to support the "Mini-Fleet" testing.

7.9.6 Mini Fleet Test

Following the completion of the Field Performance Test and Radio Coverage Acceptance Test, a comprehensive test of the integrated PSVRN and MTMS shall be conducted with a small subset of the SFMTA's fleet. The Mini-Fleet Test is intended to verify proper operation and integration of each of the SFMTA's non-revenue and revenue vehicles with the PSVRN and/or MTMS fixed-end equipment.

The mini-fleet will consist of each different bus type, rail vehicle type, cable car, and each different non-revenue vehicle type. These vehicles shall be equipped with all required on-board vehicle equipment including optional equipment purchased. These vehicles shall be operated in actual or simulated revenue or non-revenue service to fully test, at a minimum, the following under actual service conditions:

- Schedule and route adherence
- Automatic Vehicle Location
- Voice communications and data messaging
- Emergency alarm processing
- Real-time traveler information feed
- All other PSVRN and MTMS equipment, functions, and all other options purchased.

This test shall verify that all PSVRN and MTMS components have been supplied, installed, and perform all functions in accordance with their specified requirements. The Mini-Fleet Test vehicles may be operated on a selected subset of the SFMTA's routes, provided these selected routes encompass the entire service area and will allow testing of all the operational and functional conditions expected to be encountered during the service day and throughout the entire service area.

One bus shall be operated on each route to verify proper operation of the Automatic On-Board Traveler Information System.

One bus shall be operated on each route to verify proper operation and specified accuracy for existing traveler information system feed.

The test shall also verify mechanical, electrical, and electromagnetic compatibility with all other existing on-board equipment on all vehicles including TransLink, farebox, CCTV, vehicle monitoring systems.

This testing will be repeated as necessary until the integrated PSVRN and MTMS is ready to support revenue service for the entire fleet. The SFMTA shall provide on-site support during this test to assist in the testing and to help identify variances.

7.9.7 System Availability Test

The System Availability Test is intended to document that the PSVRN and MTMS can meet its system availability requirements.

Following the Field Performance Test, Mini-Fleet Test, and the placing of the entire vehicle fleet into revenue service under the PSVRN and MTMS, a 720-hour System Availability Test shall be conducted to verify availability requirements. All variances must be corrected, all hardware and software documentation must be delivered, and training received and approved by the SFMTA prior to the start of the System Availability Test.

During the System Availability Test, the complete PSVRN and MTMS shall demonstrate availability as specified in **Appendix Twelve (12) Section One (1)** of this Specification owing for downtime and hold time as defined below:

- **Down Time** – Downtime occurs whenever the criteria for successful operation defined in **Appendix 12 (Twelve) Section One (1)** are not satisfied. Down time shall penalize availability and will be measured from the time of failure until full service is restored. In the event of multiple failures, the total elapsed time for repair of all problems shall be counted as downtime.
- **Hold Time** – Certain events may occur that are beyond the control of both the Contractor and the SFMTA. These events may prevent successful operation of the PSVRN and MTMS but, at the same time, are not valid for the purpose of measuring availability. Such periods of unsuccessful operation may be declared "hold time" by mutual agreement of the SFMTA and the Contractor. Hold time will be availability-neutral, counting neither toward nor against availability and will not be considered in availability statistics. Specific instances of hold time events include scheduled shutdown of equipment, power interruption, or environmental excursion. Periods during which an intermittent, recurring software or hardware failure is experienced will be considered hold time, provided that the Contractor is engaged in remedial action to correct the failure.

The Contractor will be responsible for conducting the System Availability Test. The SFMTA will operate the PSVRN and MTMS according to procedures described in the approved Contractor documentation. The SFMTA staff shall record details for any system failures within a Contractor-provided form or template.

During the System Availability Test, the Contractor shall provide all maintenance according to the service levels specified in **Appendix Twelve (12) Section Eight (8) f**or the one-year warranty period.

The SFMTA shall reserve the right to require the Contractor to restart the System Availability Test based on test progress, equipment failures, system changes, etc.

After 720 hours of cumulative test time, test records shall be examined to determine if the availability criteria specified in **Appendix Twelve (12) Section One (1)** have been met. If test objectives have not been met, the test shall continue until the specified availability is achieved.

7.9.8 System Acceptance

Prior to System Acceptance, the Contractor shall demonstrate that the integrated PSVRN and MTMS fulfills all RFP requirements of Contract 1240. Final acceptance shall require, but not be limited to, the following:

- Completion of all facility work, system, component, hardware and software delivery, installation, testing, optimization, phased integration, documentation, and training.
- Acceptance of facilities, individual systems, and equipment by the SFMTA. Correction of any operational, performance, or workmanship defects shall be at the sole expense of the Contractor.
- Written certification by the Contractor of compliance with the RFP requirements, including Radio Coverage and Acceptance Test results.
- Successful completion of the Coverage Acceptance Test
- Successful completion of the System Availability Test and all pre-requisite testing

Final acceptance of the integrated PSVRN and MTMS shall only occur after:

- Completion of all contractual requirements to the SFMTA's satisfaction
- Successful completion of all tests as determined by the SFMTA acceptance and approval of all test reports
- SFMTA acceptance of all delivered equipment as listed in the Contractor provided hardware inventory
- SFMTA approval of all drawings, manuals, and all other documentation
- SFMTA approval of all CDRL items
- Integration of all revenue vehicle equipment and functionality
- SFMTA approval of PSVRN and MTMS equipment installations at all locations
- SFMTA approval of PSVRN and MTMS equipment installations on all vehicles
- SFMTA approval of all Contractor-provided training
- Correction of all variances
- Final clean-up of all installation sites
- Provision of all source code as determined by escrow requirements specified in **Appendix Twelve (12) Section Nine (9).**

Prior to final acceptance, the SFMTA may derive beneficial use from any or all components of the PSVRN and MTMS. During and prior to final acceptance, the Contractor shall provide maintenance and service as specified in **Appendix Twelve (12) Section Eight (8).**

7.10 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

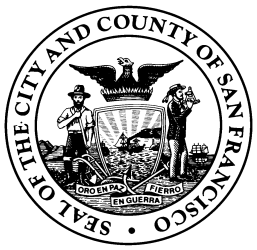
- PRL 12-7-1 Sample Coverage Acceptance Test Plan.

7.11 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-7-1 Integrated System Test Plan
- CDRL 12-7-2 Test Procedures
- CDRL 12-7-3 Test Records
- CDRL 12-7-4 Test Variance Reports
- CDRL 12-7-5 Test Variance Summary
- CDRL 12-7-6 Coverage Acceptance Test Plan.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.



appendix **twelve**: section **eight**

Training, Support, and System Maintenance

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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8.0 Training, Support, and System Maintenance

This section discusses the requirements for training, support, and system maintenance to be provided for the Public Service Voice Radio Network (PSVRN) and Multimodal Transit Management System (MTMS).

8.1 Training

The Contractor shall provide a comprehensive training program that prepares the SFMTA and City and County of San Francisco (CCSF) staff for operation, general support, preventive and corrective maintenance of all radio communication equipment, vehicle installed equipment, the base MTMS system, the base PSVRN system, and all optional components purchased. Training may be conducted by the Contractor, Contractor's Subcontractors, third-party suppliers, or original equipment manufacturers.

In response to the RFP, the Qualified Proposer shall fully describe the training program to include, as a minimum, classroom style instruction, operational style classes, a detailed training plan, session duration, description of available training material, and resumes of potential course instructors **[PRL 8-1 "Training Program Description"]**. As part of **PRL-1, Training Program Description**, the Qualified Proposer shall indicate which courses will require Subcontractor instruction, and the names, contact information, and references of Subcontractors that the Proposer expects to execute this training.

The Contractor shall submit to the SFMTA a comprehensive training plan based on the requirements discussed in this section, **[CDRL 8-1 Training Plan]**.

8.1.1 Dispatcher Training

The Contractor shall provide Dispatcher training in the use of the PSVRN dispatch console and MTMS workstations. This course shall provide a thorough understanding of the user interface, startup, and operation, general design, systems concepts and features, and error messages. Training shall be provided for the base system and all options purchased.

8.1.2 Vehicle Operator Instructor Training

The Contractor shall provide training for the SFMTA vehicle operator instructors for each type of vehicle. Training shall include a thorough understanding of operation and user interface of all vehicle installed equipment, including general system design concepts and features. Training shall include hands-on training using the actual hardware and software being delivered to the SFMTA.

Training shall be organized by vehicle type, including distinct training for rubber-tire vehicles, light rail vehicles, historic vehicles, cable cars, and non-revenue vehicles.

The Contractor shall provide each user laminated “quick-start” guides (preferably pocket-sized) instructing the user on the proper use of the equipment in operational circumstances.

8.1.3 Vehicle Operator Training Hardware

To assist in efficiently and effectively training SFMTA’s diverse group of vehicle operators, the Contractor shall provide equipment in desktop enclosures for classroom use.

The Contractor shall provide the following on-board vehicle equipment for training vehicle Operators and other staff on the proper use and operation at SFMTA’s training facilities:

- Ten (10) sets of training equipment for training bus Operators
- Two (2) sets of training equipment for training Light Rail Vehicle Operators
- Two (2) sets of training equipment for training non-revenue vehicle operators.

Each set of the training equipment shall be mounted within a rigid frame, equipment box, or enclosure suitable for placement on a desktop and for use by the personnel being trained. The training equipment shall be fully operational and shall be identical to the equipment being provided and installed by the Contractor in SFMTA’s vehicles. The equipment shall interconnect to the MTMS and PSVRN central systems using an over-the-air connection to the trunked radio and data systems. The equipment shall provide both voice and data messaging functionality, identical in operation to that provided on the revenue and non-revenue vehicles. The equipment shall include the necessary power conversion equipment to operate from a standard 120VAC outlet.

One (1) set of bus and one (1) set of light rail vehicle training equipment shall be tested as part of the factory acceptance testing. All equipment shall be delivered to the SFMTA four (4) weeks prior to performing the vehicle operator training.

8.1.4 Radio Communications Subscriber Unit Training

The Contractor shall provide instructor training on radio system subscriber unit operation, using both the MTMS and PSVRN functionality, including an overview of the system. The Contractor's training on radio operations shall include training in orientation, management, and operation of all subscriber equipment provided including:

- Mobile radios
- Portable radios
- Desktop consoles
- Control stations
- All accessories
- Alternative support systems, diagnostic systems, specialized equipment for system monitoring, etc. as displayed at the dispatch console.

The training shall be designed so that upon completion, the student shall be qualified to train system end users on the operation of the equipment.

The Contractor shall provide each user laminated "quick-start" guides (preferably pocket-sized) instructing the user on the proper use of the equipment in operational circumstances.

8.1.5 LMR Network Management System Training

Separate training shall be provided for the radio communications system (LMR) Network Management System. Training shall include system orientation and familiarization, including discussion and equipment demonstration. The Contractor shall conduct comprehensive classroom console operator training for the communications personnel operating the new LMR Network Management System (NMS) in two separate sessions:

- Session 1 shall be conducted in a classroom environment, using training aids, and a model of the SFMTA's LMR NMS environment, including all components for both the MTMS and PSVRN
- Session 2 shall also be conducted using operational NMS console equipment on the live system.

Training shall be conducted on-site during system optimization. The training schedules shall be arranged and conducted with each student attending Sessions 1 and 2 (once as a minimum).

8.1.6 General Network Management System Training

The Contractor shall provide training for all network management components provided, in addition to that provided for the LMR equipment (Section 8.1.5). The course content shall include the following, as a minimum:

- Documentation structure, numbering system, and configuration control system
- Block diagram and system description
- Installation documentation
- Use of software applications
- Trouble diagnosis to module level
- Troubleshooting techniques
- Adding future components to be monitored
- Operation and administration of network security and configuration management utilities
- Database management.

8.1.7 System Administration Training

This course shall provide training on all of the procedures necessary to configure, operate, and maintain the PSVRN, MTMS, and all other purchased options (with the exception of the radio communications system discussed below) in an efficient, controlled, and well-documented manner. These courses shall include, as a minimum, training in:

- System database structure, content, organization, and maintenance
- Computer server system administration for all installed applications
- System backup procedures
- System restoration and disaster recovery procedures
- Installing software updates provided by the Contractor or third-party software suppliers
- Periodically updating the schedule and other data that is imported into and/or exported from the system
- Managing all other system interfaces including those to Trapeze, 511.org, farebox, and TransLink
- Interpreting and responding to messages generated by all error-monitoring software
- System administration for all options purchased

- Report generation and development
- Incident form development
- System user security access including management of user roles and responsibilities.

8.1.8 Radio System Maintenance Training

The Contractor shall provide separate maintenance level factory certified training for the SFMTA and CCSF technical staff for all PSVRN and MTMS radio communications components and equipment.

Training shall include system orientation, management, operation, and maintenance of all system infrastructures and associated system equipment provided.

The training shall include education on the theory of operation, preventive maintenance, and corrective maintenance procedures for the entire system infrastructure and all systems contained therein.

The training shall be designed so that upon completion, a technician will be qualified to perform all levels of installation and setup, optimization, phasing, troubleshooting, and maintenance of the system to the removable component level.

The Contractor shall permit the SFMTA and CCSF staff to videotape maintenance and alignment procedures performed on equipment.

The course content shall include the following, as a minimum:

- Use of diagnostic software and tools
- Use of alarm monitoring equipment
- Documentation structure, numbering system, and configuration control system
- Block diagram and circuit description—all units
- Installation and turn-on procedure
- Alignment, phasing, and testing procedure
- Trouble diagnosis to unit and board level
- Unit replacement procedure
- Operating and safety
- Traffic continuity procedures.

8.1.9 Vehicle Equipment Maintenance Training

The Contractor shall train selected the SFMTA staff to be qualified instructors in the maintenance of vehicle equipment. Training shall include, for revenue and non revenue vehicle types, as a minimum:

- System overview
- Vehicle review (installed operational vehicle)
- Maintenance manual layout and installation drawings
- Vehicle equipment descriptions including all individual components
- Descriptions of vehicle interfaces
- ITS equipment overview
- Radio, VLU, and MDT programming
- Radio and ITS options maintenance
- Diagnostics, troubleshooting, and adjustments
- Simulated troubleshooting
- Vehicle on board equipment interface maintenance
- Return material authorization procedures.

8.1.10 Training of Other System Users

The Contractor shall review the SFMTA's and CCSF's organization and include plans for all other SFMTA and CCSF system user including, as a minimum, staff from:

- Administration
- Customer Service (SFMTA and CCSF 311 staff)
- Safety and Security
- Planning.

8.1.11 Training Schedule

The Contractor shall schedule and provide the training courses as appropriate for the overall project schedule and shall coordinate with the SFMTA to schedule training **[CDRL 8-2 "Training Schedule"].** Training shall be "just in time" so that there is not an extended gap between training execution and system implementation.

The Contractor shall develop a training schedule in consultation with the SFMTA after Contract Award. The training schedule shall include all the SFMTA shifts (e.g. day, swing, and grave) and coincide with the actual SFMTA hours for these shifts. For each course, the following requirements shall apply:

- The Contractor shall provide a list of course objectives and core competency skills for each training session at least 90 days in advance of the first scheduled session
- Whenever possible, the training should be conducted with substantial hands-on involvement using the SFMTA's systems and equipment
- The Contractor shall train the SFMTA employees, Contractors, or the other SFMTA and CCSF designees on the premises or other such locations approved by the SFMTA, unless otherwise specified.

As part of their work scope, the Contractor shall include 20% of training hours held in reserve to address problem areas experienced during operation and maintenance, or as a result of system changes based on updates, or warranty actions.

8.1.12 Training Location

With the exception of radio system maintenance training, all training shall be conducted at the SFMTA facilities. If the Contractor determines that a particular training course must be conducted elsewhere, the Contractor must demonstrate need and receive SFMTA approval.

The SFMTA will attempt to provide classroom facilities for all training conducted at a SFMTA facility. If such facilities are not available, the SFMTA shall request that the Contractor arrange other suitable facilities within the City of San Francisco, at the SFMTA's expense, subject to prior written review and approval.

8.1.13 Class Size

The Contractor shall provide training for the following SFMTA personnel:

Course	Maximum Participants
8.1.1 Dispatcher Training	**40**
Error! Not a valid result for table.	**12**
Error! Not a valid result for table.	**30**
8.1.5 LMR Network Management	**12**
System Administration Training	**24**
8.1.8 Radio System Maintenance Training	**15**
Error! Not a valid result for table.	**20**
Other System Users	**30**

For radio system maintenance training, the Contractor shall provide:

- Round trip transportation from San Francisco to the LMR system provider's training location, including all transfers
- Hotel accommodations
- Federal per diem allowance for meals and incidental expenses in the host city.

The SFMTA and CCSF staff shall be able to attend this training separately in order to minimize disruption of service and operations.

8.1.14 Training Manuals and Equipment

The Contractor shall prepare training manuals and agendas for each training course **[CDRL 8-3 "Training Manuals and Agendas"]**. These manuals and agendas shall be submitted to the SFMTA for review sixty (60) days prior to the start of classroom instruction. Principal collateral used for training shall be tailored to reflect all of the SFMTA's specific hardware, software, terminology, and user requirements. Reference manuals, maintenance manuals, and user's manuals may be used as supplementary training material but not as the primary training manual.

Upon completion of each course, instructor's manuals, training manuals, and training aids shall become the property of the SFMTA. As part of the delivered system documentation and the final documentation, the Contractor shall supply the SFMTA with all changes and revisions to the training manuals and other training documentation, through completion of the warranty period. The SFMTA reserves the right to copy and distribute all training manuals and aids for use in the SFMTA and CCSF conducted training courses.

The Contractor shall furnish for use during training courses all special software, equipment, training aids, and any other materials required to train course participants. The number of training manuals, special tools and other training equipment shall be adequate for the number of participants attending each course. Training documentation shall be submitted in accordance to the documentation requirements in **Appendix Twelve (12) Section Nine (9).** For each course, the following training materials shall be used:

- Training aids (e.g., videos, system diagrams, training manuals, mockups) showing functionality
- The Contractor shall provide one set of manuals per student plus an additional six sets of manuals
- All manuals shall be provided as an editable Microsoft Word document accompanied by an Adobe Acrobat PDF document
- Six CD ROM copies of training documentation shall be supplied.

There shall be no restrictions or licensing requirements for the SFMTA's or CCSF's use of vendor provided reference or training information when used for the SFMTA or CCSF training purposes.

In addition to specific coverage requirements stated within each course, training shall include system orientation and familiarization, including discussion and equipment demonstration.

8.2 System Support Services

Throughout the design, implementation, testing, and field installation phases of the project, the Contractor shall supply all engineering data and services, as required by the SFMTA. The Contractor shall provide support regarding the necessary site preparations, communication facilities, field installation of equipment, system cutover, and solutions to technical problems. These support services shall apply to all components provided for the PSVRN, MTMS, all optional equipment purchased, all interfaces, all software, and operational requirements.

8.2.1 System Setup

With the SFMTA's support and input, the Contractor shall be responsible for initially setting up the system and for entering or loading all the required data into the devices and systems, including but not limited to the following:

- Defining and setting up the hardware and software configurations
- Defining and configuring the user accounts, roles, and security permissions
- Defining and configuring all data required for system databases
- Defining and configuring the routing of CAD event queue entries
- Defining and configuring the canned mobile data terminal messages
- Successfully importing all schedules and route definitions from the SFMTA's Trapeze scheduling system
- Setting the initial values for all user-adjustable parameters
- Entering all radio communications parameters
- Configuring all network devices for security and accessibility
- Configuring all interface parameters
- Importing all Radio Dispatcher reference information and procedure files
- Setting the initial schedule and route deviation reporting thresholds
- Installing the latest update of the GIS database
- Verification of the SFMTA bus stop geo-coding data.
- Defining and configuring all other data necessary for a functional MTMS and PSVRN.

8.2.2 System Packaging and Shipment

The Contractor shall pack, crate, or otherwise suitably protect all equipment to withstand shipment to the appropriate the SFMTA and CCSF locations. Packing methods shall meet or exceed manufacturer's recommendations. Equipment shall be shipped assembled and completely wired wherever possible.

The size and nature of available doors, stairways, elevators, and other passageways with access to the SFMTA and CCSF sites where equipment is to be installed shall be verified by the Contractor. Shipping instructions and plans shall be developed according to these inspections. The equipment shall be shipped and moved into place without requiring modification or alteration to any building.

All equipment shall be shipped F.O.B. to the specified the SFMTA or CCSF location. The Contractor shall provide a contact list to the shipper or coordinate with the SFMTA Project Manager. Contractor shall bear all risk of loss or damage for all equipment at all times during shipment and installation.

Each package, crate, or part shall be clearly marked with the name of the recipient, shipping destination, the SFMTA contract number, and other such markings as appropriate. Complete packing lists shall be supplied showing the contents and identity of each package. One copy of the list shall be securely attached to the outside of each shipping unit. The Contractor shall send another copy of the list to the SFMTA's Project Manager prior to delivery.

The equipment shall be shipped to addressees designated by the SFMTA. The SFMTA shall be notified by the Contractor two (2) weeks prior to any shipment and again forty-eight (48) hours prior to arrival of equipment. Equipment shall be delivered during times mutually agreed upon by the SFMTA and the Contractor unless prior approval has been granted by the SFMTA.

Upon delivery of equipment at a specified the SFMTA location, the SFMTA will undertake a visual inspection of delivered equipment. The SFMTA will issue a notice of receipt for all delivered equipment. This notice shall not constitute acceptance of any equipment but shall only indicate that delivery has been accomplished.

Insurance covering full replacement value on all deliverables shall be obtained and maintained by the Contractor during shipment, unloading, unpacking, and setup at the SFMTA and CCSF premises.

8.2.3 Spare Parts

The Contractor shall provide the following spare parts as listed in the "**Cost Proposal Form" (Appendix Twenty-Eight (28))**:

- Spare on-board Automatic Vehicle Location (radio, VLU, MDT, etc.) equipment for revenue vehicles
- Spare on-board digital voice announcement equipment for revenue vehicles
- Other required on-board vehicle equipment
- Other spare parts as specified.

8.2.4 Spare Parts End-of-Life

If at any time, the Contractor, or supplier to the Contractor, plans to discontinue manufacturing any of the on-board devices provided to the SFMTA, the Contractor shall notify the SFMTA accordingly. The SFMTA shall have the opportunity to purchase any of the spare parts that are being discontinued that the SFMTA requires for the PSVRN and/or MTMS.

8.2.5 Long Term Material Support

The Contractor shall warrant support in the form of replacement parts for the Contractor's mobile and portable equipment for a minimum of ten (10) years from the last date of manufacture of the product, and for a minimum of ten(10) years from the last date of manufacture on all other Contractor provided equipment. If the identical replacement part is no longer available, the Contractor's support shall include providing of replacement parts that are form/fit/function compatible with the existing system configuration.

Technology refresh of computer server network equipment that will have less than the required ten (10) year life from end of manufacture shall be identified along with a replacement schedule.

8.2.6 Test Equipment and Software

The Contractor shall provide all special test equipment, instrumentation, cable harnesses, break-out boxes, software, etc. The Contractor shall also provide two (2) radio communications service monitors of the SFMTA's choosing capable of supporting the new radio system technologies being utilized.

8.3 System Maintenance

At all times prior to System Acceptance, the Contractor shall be fully and solely responsible to ensure that the PSVRN and MTMS meets all requirements of these specifications, and for all system maintenance as defined below to meet the system availability requirements specified in **Appendix Twelve (12) Section One (1)**.

All non-conforming or defective equipment shall be immediately repaired or replaced to the SFMTA's satisfaction, according to the Contractor's QA Program Plan.

8.3.1 One Year Warranty

The Contractor shall be responsible for maintenance of the PSVRN and MTMS during the one (1) year warranty period. The one (1) year warranty period shall begin upon System Acceptance of the entire system by the SFMTA and extend for one (1) year following System Acceptance.

The following level of service shall be provided during the one (1) year warranty period:

System Element	Service Level
All Contractor-provided mobile and portable hardware and software	**Daily on-site support during SFMTA's normal business hours.** **Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.**
All Contractor-provided fixed equipment and hardware including but not limited to base stations, site controllers, NMS, antenna systems, power supplies, computer servers, and network equipment.	**Four (4) hour on-site response, twenty-four (24) hours per day, seven (7) days per week, 365 days per year.** **Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.**
Fixed equipment software including but not limited to application software, database management systems, security software, and NMS.	**Four (4) hour on-site response, twenty-four (24) hours per day, seven (7) days per week, 365 days per year.** **Remote technical phone support shall also be available Monday through Friday during SFMTA's normal business hours.**

Qualified Proposers are required to quote warranty support to the levels described above. Qualified Proposers may recommend, as part of their submittal, additional alternative maintenance approaches based on their experience deploying systems similar in size and technology to that required by the SFMTA.

8.3.2 Extended Support Program

As an Optional Service, Qualified Proposers shall offer pricing for three subsequent years for an Extended Support Program taking affect after the end of the one (1) year warranty period. Prior to the end of the one (1) year warranty period, the SFMTA may, at its discretion, enter into discussions with the Contractor to provide coverage on a portion or all of the equipment provided under the Extended Support Program. Unless otherwise specified, Qualified Proposers shall assume that each year of the Extended Support Program will provide the same level of service as the One Year Warranty specified above.

8.4 SFMTA Provided Project Space

The SFMTA will likely be able to provide space within the Muni Metro East facility to enable the Contractor to place up to four (4) 40-foot steel storage (“Conex” style) containers and a construction trailer to store equipment and tools. In such case, it will still be the Contractor’s responsibility for provisioning and paying for power and telecommunications connectivity to their trailer and containers. If required, the SFMTA will work with the Contractor to facilitate connection of power and telecommunications service.

8.4 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Qualified Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12- 8-1 Training Program Description.

8.5 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12- 8-1 Training Plan
- CDRL 12- 8-2 Training Schedule
- CDRL 12- 8-3 Training Manuals and Agendas.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.

appendix **twelve**: section **nine**

Project Management, Schedule, and Documentation

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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9.0 Project Management and Documentation

This section discusses the project management and documentation requirements required to implement the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN).

9.1 Project Management Processes and Procedures

The Contractor Project Manager shall use Project Management Processes and Procedures as described by Project Management Institute (PMI) standards. This includes incorporation of any and all processes and procedures as described in the "Project Management Body of Knowledge (PMBOK)" Guide (ANSI/PMI 99-001-2008) as required by the SFMTA at the beginning and throughout the life of the Project.

9.2 Project Management Tasks

The Contractor shall appoint a full-time Project Manager who will be the single point of contact to the SFMTA for the project. The Project Manager will work out of the local project office, as defined to follow.

At project inception, within twenty-one (21) days of receipt of Notice to Proceed (NTP), the Contractor shall submit a Critical Path Method (CPM) project schedule that includes milestones and a work plan, for the SFMTA review and approval **[CDRL 12 - 9-1 CPM Project Schedule]**. The approved CPM project schedule will bethe baseline schedule. The schedule must be updated on a monthly basis.

The Project Manager shall coordinate resources and work so that milestones are met in an efficient manner. Tasks will be scheduled to minimize implementation time, while taking into consideration resource and time constraints (such as the SFMTA's staff availability). The Project Manager shall ensure that employees performing tasks have appropriate skill levels and credentials. The SFMTA reserves the right to require the Contractor to remove or reassign any individual on the Contractor's Project team if the SFMTA is unsatisfied with that person's performance or that person fails to demonstrate the required qualifications or expertise. The SFMTA reserves the right to review and approve replacement team members.

The Contractor shall submit a Project Management Plan within two (2) weeks of NTP **[CDRL 12-9-2 Project Management Plan]**.

9.3 Project Management Reporting

As part of the Contractor's regular project management activities, the Project Manager shall:

- Participate in and conduct bi-weekly project progress review meetings and other related meetings as appropriate. Bi-weekly progress review meetings will be jointly scheduled by the SFMTA's and the Contractor's Project Manager, and must be attended by both managers, other necessary personnel, as well as additional personnel requested by the SFMTA. Progress review meetings will be conducted at a SFMTA facility or other agreed upon location, and shall be used to review, at a minimum, the progress, schedule, written correspondence exchanged since the last meeting, and open action items, to obtain clarifications, request information, and discuss future activities. The Contractor Project Manager will prepare a meeting agenda for and record the minutes of each meeting and forward a copy to MTA for review and approval.
- The Contractor will participate in meetings as requested by the SFMTA to discuss technical aspects of the project, and to review comments on the Contractor's submittals. When appropriate, these meetings may be conducted as extensions to the progress meetings.
- Prepare monthly project progress/status reports in both electronic and hard-copy to the SFMTA within five (5) working days after the end of the preceding month. The progress report must include the following items:

    1. An updated project schedule including milestone and work plan updates with explanations of any deviations from the planned delivery schedule. Each explanation should include the anticipated impact of any delays and a plan for returning to the target schedule. All delays must be factored into the project schedule as soon as the Contractor's Project Manager has knowledge of them. In addition, all changes to the schedule since the last progress report and items on critical path must be identified. Any changes to the project schedule or work plan shall be reviewed and approved by the SFMTA.
    2. An update to the Project Management Web Portal (described below), of all correspondence transmitted and received during the month. Additional hard copy listings will be provided at the SFMTA's request.
    3. An updated documentation schedule, highlighting the documents to be transmitted for review during the next two reporting periods.
    4. An update to the Project Management Web Portal, of open action items, uniquely numbered, with status and required resolution dates. Additional hard copy listings of action items will be provided at the SFMTA's request.
    5. The status of open change requests and change orders.
    6. A description of current and anticipated project problem areas or risks and steps to be taken to resolve each problem.

- Participate in and conduct project presentations and briefings, as requested by the SFMTA.
- Participate in as-needed conference calls to review any technical, schedule, action item, deliverable, coordination, or project management issues that need to be discussed in order to help keep the project on schedule. These conference calls shall be scheduled for a mutually agreeable time, preferably at the same day and time each week. These conference calls shall be conducted informally, and both the Contractor and the SFMTA may propose topics to be discussed. A scheduled conference call may be canceled anytime at the SFMTA's discretion.
- Manage project transmittals, using the Project Management Web Portal described herein.
- Participate in community meetings and assist in community outreach and regulatory processes.

For the duration of the project, the Contractor must maintain a project office located within twenty-five (25) miles of the City of San Francisco. The project office must be staffed to provide timely and adequate technical and administrative personnel support to the Project.

The Contractor shall provide a Project Management Web Portal for storage and retrieval of design documents, design drawings, correspondence, and other supporting documents. The web portal shall be accessible using a standard web browser (e.g. Internet Explorer or Mozilla Firefox) and secure connection, and not rely on any specialized client software.

9.4 Project Schedule

In their response to this RFP, the Proposer shall include a draft project schedule, showing how the requirements below can be met **[PRL 12 - 9-1 Project Schedule]**.

The Project shall be scheduled to meet the following requirements:

Milestone	Weeks after NTP
Submit project schedule	**1**
Submit Quality Assurance Plan	**2**
Establish local project office	**6**
Complete Intermediate (65%) Design Review	**16**
Complete Final (100%) Design Review	**42**
Completion of fixed site construction	**82**
Completion of on-site integration testing including radio coverage acceptance test	**92**
Production vehicle installations and cutover completed	**118**
Successful completion of Reliability Demonstration Test (base system)	**130**
Completion of advanced features and options	**156**

9.5 Documentation

The Contractor shall provide complete documentation for the MTMS and PSVRN. Each document shall be identified by a Contractor document number and the SFMTA Contract No. 1240. Where a document is revised for any reason, each such revision shall be indicated in accordance with the Contractor's Quality Assurance procedure for design and change control.

Documents shall be submitted in accordance with the Contractor's Quality Assurance procedure for document control. Preliminary and draft electronic copies of all documents shall be submitted to the SFMTA in "MS-Office" format for commenting, proposed changes, corrections, etc. Final copies of all documents shall be provided to the SFMTA in MS-Office and Adobe Portable Document Format (PDF). Copies of documents or drawings scanned to/saved as PDF format only will not be acceptable (documents must be editable and searchable).

As a minimum, the following documentation shall be provided.

9.5.1 System Functional Description Document

A System Functional Description Document (SFDD) shall be provided that contains a high-level definition of the specific hardware, software, firmware, interfaces, and the functions performed by each **[CDRL 12-9-3 System Functional Description Document]**. The SFDD shall serve as a complete introduction to the MTMS and PSVRN and to the more specific hardware and software documents below. The following information, as a minimum, shall be included in the SFDD:

- An overview of the hardware configuration showing all major hardware subsystems. The overview shall include block diagrams in sufficient detail to show the interrelationships of major hardware subsystems and the elements that comprise them.
- A description of the major hardware subsystems, the elements that comprise them, their interrelationships, and the functions they perform. Major requirements imposed on the configuration such as system availability, processor performance, spare mass storage, and device redundancy shall be described.
- An overview of the major software subsystems describing the software, the interrelationship of software within a subsystem, and the relationship between subsystems. High-level software subsystem block/flow diagrams shall be included to enhance the reader's understanding of the overall capabilities of the MTMS and PSVRN. The subsystems to be described shall include, as a minimum, the Computer Aided Dispatch, Automatic Vehicle Location, radio communications system, operating system, network backhaul, network software, system interfaces, system security, historical storage, support utilities, database, map, interfaces, and report generation. Descriptions for all purchased options shall also be included in this document.

A complete description of the software and the individual functions performed by the software shall be provided. Significant features, concepts, and algorithms pertaining to each function shall be described with special emphasis on equipment, software, and features unique to the MTMS and PSVRN.

9.5.2 Hardware Documentation

Documentation for all supplied hardware shall be provided. In addition to the documentation specifically identified below, the Contractor shall provide the SFMTA with all documentation originally supplied with standard OEM hardware devices purchased from others.

Hardware Inventory, Floor Plans, and Wiring Diagrams

The following items shall be provided by the Contractor:

- Inventory of all hardware to be supplied, including the manufacturer's name, model number, serial number, name plate data, overall dimensions, and quantities **[CDRL 12-9-4 Hardware Inventory]**
- An inventory of all hardware documentation. The Contractor shall maintain the inventory list through final acceptance of the system **[CDRL 12-9-5 Hardware Documentation Inventory]**
- Vehicle equipment installation drawings showing how the on-board equipment provided by the Contractor is to be installed and connected on each type of vehicle **[CDRL 12-9-6 Vehicle Installation Drawings]**
- Detailed installation wiring and cabling diagrams. Any special precautions associated with cabling shall be clearly identified. All cable and wiring terminations shall be shown on drawings, and all terminal markings, cable connector markings, and cable lengths shall be clearly indicated **[CDRL 12-9-7 Installation Wiring and Cable Diagrams]**.

Site Preparation Manuals

To supplement the detailed site drawings, physical planning and site preparation manuals shall be provided for all hardware **[CDRL 12-9-8 Site Preparation Manuals]**. The manuals shall contain, but not be limited to:

- Site floor plans indicating rack, cabinet, console, and peripheral device locations and sizes for each fixed radio site, bus yard, and the Lenox Way Operations Control Center **[CDRL 12-9-9 Site Floor Plans]**. The locations and sizes of all equipment to be mounted in each rack, cabinet, and console shall be identified.
- Drawings of all racks, cabinets, enclosures, consoles, computer, and communications equipment
- Mounting details, clearance requirements, and environmental restrictions
- Antenna alignment details

- Electrical power supply requirements
- Heat dissipation specifications
- Device installation requirements.

Radio System Technical Data

The Contractor shall provide the Radio System technical data as specified in **Appendix Twelve (12) Section Two (2)**.

Reference and Instruction Manuals

Reference and instruction manuals shall be provided for all hardware **[CDRL 12-9-10 Hardware Reference and Instruction Manuals]**. Hardware user manuals shall be provided where applicable. These manuals shall include documentation relating to hardware, including descriptions, specifications, theory of operation, installation information, and drawings. The Contractor shall include an attachment to each document outlining those portions of the document, if any, that do not apply to the SFMTA's hardware.

Maintenance Manuals

Manuals and other descriptive material shall be provided for all Contractor-provided equipment, regardless of whether the equipment is manufactured by the Contractor or another supplier **[CDRL 12-9-11 Maintenance Manuals]**. This documentation shall include descriptions, specifications, theory of operation, printed circuit module schematics, layout drawings (showing component types and positions), motherboard schematics (showing inter-module connections), back-panel and assembly wiring diagrams, pin lists, and other electrical, electronic, and mechanical hardware data.

Instructions shall be provided for preventive and corrective maintenance procedures that include examinations, tests, adjustments, and periodic cleaning. The manuals shall provide guidelines for isolating the causes of hardware malfunctions and for localizing faults.

Complete parts lists and breakdowns with sufficient descriptions to identify each field-replaceable component shall be provided.

9.5.3 Diagnostic Program Manuals

Diagnostic program users manuals shall be provided with complete instructions on the loading and operation of all hardware and software diagnostic programs required for the equipment to be maintained by the SFMTA and City and County of San Francisco (CCSF) staff **[CDRL 12-9-12 Diagnostic Program Manuals]**. The text shall include guides for locating faults, symptoms, possible causes of trouble, and suggested remedial action. Sample printouts shall be included from the diagnostic programs, along with their explanations.

9.5.4 General Software Documentation

Documentation for all supplied software shall be provided to the SFMTA **[CDRL 12-9-13 Software Documentation]**. Software documentation shall include an inventory of all software documents, to be maintained by the Contractor through final acceptance of the complete MTMS and PSVRN systems.

Existing documentation and user manuals for third-party standard software shall be provided. Standard software is defined as field-proven software purchased from third-parties or software developed internally as a base for all projects, that fully satisfies the requirements of this Specification without modification for the SFMTA. Typical examples include operating systems, compilers, software development utilities, software diagnostic programs, network managers, interface specifications, web services, XML schema and definitions, and window managers.

9.5.5 Software Functional Requirements Document

A Software Functional Requirements Document shall be provided covering each MTMS and PSVRN function **[CDRL 12-9-14 Software Functional Requirement Document]**. It shall contain the following information for each software function:

- An introduction describing the purpose of the function with references to other documents to aid the reader's understanding of the functions performed
- A complete description of the function
- A complete description of the algorithms, operation, and the data and logic interfaces with other functions.

9.5.6 Program Source Code

The Contractor shall provide a machine-readable copy of all source code, installers, and executable files developed for the SFMTA **[CDRL 12-9-15 Program Source Code]**. Source code and executables shall also be provided for interfacing the MTMS and PSVRN to other SFMTA and CCSF systems and for all displays
and reports developed specifically for the SFMTA. The machine-readable files provided shall contain all the data required to enable the SFMTA to restore, reinstall, add, modify, or delete the SFMTA specific applications, displays, reports, and interfaces to other systems.

For the remainder of the software and firmware, the Contractor shall provide an escrow agreement that guarantees the SFMTA access to the source code and other files of the software and firmware should the Contractor be unwilling or unable to perform future system software/firmware maintenance or modifications required by SFMTA **[CDRL 12-9-16 Software Escrow Agreement]**.

9.5.7 Database Documentation

Database documentation shall be provided that describes the structure of the MTMS and, if applicable PSVRN relational database server databases **[CDRL 12- 9-17 Database Documentation]**. The documentation shall define the individual elements (files, records, fields, and tables) that comprise the interrelationship of elements in different sub-databases. Portions of the database developed specifically for the PSVRN and MTMS shall be identified. The Contractor shall provide user documentation for the database management system or database access routine utilized by the Contractor. A database dictionary shall also be provided **[CDRL 12-9-18 Database Dictionary]**.

9.5.8 PSVRN and MTMS User Manuals

Separate PSVRN and MTMS User Manuals shall be provided that contains detailed operating instructions and procedures to be used by all the SFMTA and CCSF users **[CDRL 12-9-19 PSVRN User Manual] [CDRL 12- 9-20 MTMS User Manual]**. The PSVRN and MTMS User Manuals shall include a description of the operation of the PSVRN and MTMS (hardware, software and radio equipment) as it relates to the user's tasks.

The PSVRN and MTMS User Manuals shall be customized for the SFMTA and shall be based on the delivered system configuration. It is not acceptable to describe the Contractor's standard system and then identify differences between the standard and delivered systems. The PSVRN and MTMS User Manuals shall not include standard or optional descriptions that do not apply to the delivered PSVRN, MTMS and/or their options.

The PSVRN and MTMS User Manuals shall describe each function and how it is to be used. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The PSVRN and MTMS User Manuals shall include a copy of each type of display and report used along with a description of each data field. User instructions for each display shall be provided.

The PSVRN and MTMS User Manuals shall describe procedures to be followed as a result of computer system restarts, failures, and failovers, and failures of elements of the radio system. The PSVRN and MTMS User Manuals shall have sufficient information to guide users on how to restart and reconfigure each system and subsystem.

9.5.9 Revenue Service Operator Manuals

The Contractor shall provide revenue service Operator Manuals for each type of vehicle (rubber-tire, light rail vehicle, historic vehicle, etc.) that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed on-board the SFMTA's revenue vehicles **[CDRL 12-9-21 Revenue Service Operator Manuals]**. Information in the manual shall be presented in terms that are meaningful to the Operators. The operation of the equipment shall be explained as it relates to each of the Operators' tasks.

All of the features and functions of the equipment installed in the vehicle, including options, shall be explained in the manual. The Operator Manuals shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Revenue Service Operator Manuals shall be delivered to the SFMTA at least three weeks prior to the start of Operator training courses.

The Contractor shall also provide quick-guides for each type of revenue service vehicle, laminated, in half-sheet format.

9.5.10 Field Supervisor Manual

The Contractor shall provide a Field Supervisor Manual that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed in Field Supervisor vehicles **[CDRL 12-9-23 Field Supervisor Manual]**. Information in the manual shall be presented in terms that are meaningful to the Field Supervisor personnel. The operation of the equipment shall be explained as it relates to the Field Supervisor tasks.

All of the features and functions of the equipment installed in the Field Supervisor vehicles shall be explained in the manual. The Field Supervisor Manual shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Field Supervisor Manuals shall be delivered to the SFMTA at least three weeks prior to the start of the Field Supervisor training course.

9.5.11 Non-Revenue Vehicle Manual

The Contractor shall provide a Non-Revenue Vehicle Manual that contains detailed operating instructions and procedures on all of the Contractor-provided equipment to be installed in Non-Revenue vehicles [**(CDRL 12-9-23 Non-Revenue Vehicle Manual]**. Information in the manual shall be presented in terms that are meaningful to the Non-Revenue vehicle operators. The operation of the equipment shall be explained as it relates to the Non-Revenue vehicle tasks.

All of the features and functions of the equipment installed in the Non-Revenue vehicles shall be explained in the manual. The Non-Revenue Vehicle Manual shall be customized for the SFMTA and shall be based on the delivered equipment. It is not acceptable to describe the Contractor's standard equipment and then identify differences between the standard and delivered equipment. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be entered, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The final Non-Revenue Vehicle Manuals shall be delivered to the SFMTA at least three weeks prior to the start of the Non-Revenue Vehicle operator training course.

9.5.12 System Administrator Documentation

User-oriented system documentation shall be provided to guide the SFMTA and CCSF personnel |in the operation and procedures required to maintain and update the MTMS and PSVRN, including system software and firmware, database, application software, and other system elements **[CDRL 12-9-24 PSVRN System Administration Documentation] [CDRL 12-9-25 MTMS System Administrator Documentation].** System Administrator documents shall be provided for the following items, as a minimum:

- Software code management
- Programming language compilers and assemblers
- Network communications management
- System performance monitoring and tuning
- System restart failover management and diagnostic procedures
- System management
- Database management
- Report generation and management
- GIS management
- Diagnostic programs
- Software utilities
- System restoration, rebuilding, and disaster recovery
- System backups
- All third-party and OEM software and utilities
- Other Contractor-supplied system software not included above.

The MTMS and PSVRN System Administration Manuals shall contain separate appendices for each option purchased.

9.5.13 Test Documentation

Documentation for all factory, field, and availability tests shall be provided in accordance with the requirements defined in **Appendix Twelve (12) Section Seven (7)**.

9.5.14 Training Documentation

Training documentation shall be provided in accordance with the requirements defined in **Appendix Twelve (12) Section Eight (8)**.

9.5.15 Radio Dispatcher Users Manual

A MTMS and PSVRN Radio Dispatcher's Manual shall be provided that contains detailed operating instructions and procedures to be used by the dispatcher personnel **[CDRL 12-9-26 PSVRN Radio Dispatcher Manual] [CDRL 12-9-27 MTMS Radio Dispatcher Manual]**. This Dispatcher Manuals shall include a description of the operation of the PSVRN and MTMS (hardware, software and radio equipment) as it relates specifically to the Dispatcher's tasks.

The Dispatcher Manuals shall describe each function and how it is to be used. Procedures shall be explained step-by-step with an explanation of how each step is performed, which parameters can be adjusted, and the effects obtained by varying each parameter. All user guidance and error messages shall be described, along with the steps necessary to recover from errors.

The manuals shall include a copy of each type of display and report available specifically to Dispatchers using the PSVRN and MTMS along with a description of each data field. User instructions for each display shall be provided.

9.5.16 Utilization of a Requirements Traceability Matrix

Within forty-five (45) days of Notice to Proceed (NTP), the Contractor shall submit a Requirements Traceability Matrix (RTM) to the SFMTA that captures the contractual, regulatory and statutory requirements of the project **[CDRL 12-9-28 Requirements Traceability Matrix]**. The RTM shall be maintained by the Contractor Project Manager, and reference design, evaluation, testing, and quality control elements satisfying each requirement. Each requirement shall be uniquely numbered and fit in a hierarchical breakdown of requirements. The RTM shall be maintained and used to guide project execution, such as management of corrective action requests, test plans and test cases, throughout the duration of the project.

9.5.17 Options Documentation

The Contractor shall provide specific documentation for all options purchased **[CDRL 12-9-29 Options Documentation]**. Documentation requirements for options shall be the same as for the base equipment.

9.5.18 Document Quantities

In additional to electronic "soft" copy, the Contractor shall provide the following quantities of bound paper "hard" copies for each submittal:

Document (Section #)	Review Copies	Final Copies
System Functional Description Document	20	20
Hardware Documentation	20	20
Inventory, Floor Plans, Wiring, Block Diagrams	20	20
Site Preparation Manuals	20	20
Radio System Technical Data	20	20
Reference Manuals and Instruction Books	20	20
Maintenance Manuals	20	20
Diagnostic Program Manuals	20	20
Software Documentation	20	20
Program Source Code	20	20
Database Documentation	20	20
PSVRN and MTMS User Manual	20	20
Bus Operator Manual	20	20
Ferry Operator Manual	20	20
Field Supervisor Manual	20	20
Non-Revenue Vehicle Manual	20	20
System Administrator Documentation	20	20
Test Documentation	20	20
Training Documentation	20	20
Radio Dispatch Users Manual	20	20
Options Documentation (each option)	20	20

9.5.19 Document Review and Approval

Document review and approval shall be done in accordance with the Contractor's Quality Assurance procedure for Design Review.

To help the SFMTA manage the review and turnaround of documents during any given period, the Contractor shall stagger the release of documents over the time allocated in the project schedule for document review. The number and size of documents shall be factored into the documentation release schedule.

The SFMTA shall have the right to require the Contractor to make any necessary documentation changes at no additional cost to the SFMTA to achieve conformance with the Contract.

Any purchasing, manufacturing, or programming implementation initiated prior to written the SFMTA approval of the relevant documents or drawings shall be performed at the Contractor's risk.

Review and approval of any document by the SFMTA shall not relieve the Contractor of its overall responsibilities to satisfy system functions and features in accordance with this Contract.

9.5.20 Drawing Standards

All design drawings submitted shall comply with the SFMTA CAD drawing standard. The most recent copy of the SFMTA CAD drawing standard shall be provided, upon request, to qualified Proposers.

9.6 Proposal Requirements List (PRL) Items

In response to the Request for Proposal, the following Proposal List Items are required (Proposers need only specify, in table form, where in their proposals this information is contained):

- PRL 12-9-1 Project Schedule.

9.7 Contract Deliverable Requirements List (CDRL) Items

The following CDRL items are required, as specified within this section:

- CDRL 12-9-1 CPM Project Schedule
- CDRL 12-9-2 System Functional Description Document
- CDRL 12-9-3 Project Management Plan
- CDRL 12-9-4 Hardware Inventory
- CDRL 12-9-5 Hardware Documentation Inventory
- CDRL 12-9-6 Vehicle Installation Drawings
- CDRL 12-9-7 Installation Wiring and Cable Diagrams
- CDRL 12-9-8 Site Preparation Manuals
- CDRL 12-9-9 Site Floor Plans
- CDRL 12-9-10 Hardware Reference and Instruction Manuals
- CDRL 12-9-11 Maintenance Manuals
- CDRL 12-9-12 Diagnostic Program Manuals
- CDRL 12-9-13 Software Documentation
- CDRL 12-9-14 Software Functional Requirement Document
- CDRL 12-9-15 Program Source Code
- CDRL 12-9-16 Software Escrow Agreement
- CDRL 12-9-17 Database Documentation
- CDRL 12-9-18 Database Dictionary
- CDRL 12-9-19 PSVRN User Manual
- CDRL 12-9-20 MTMS User Manual
- CDRL 12-9-21 Bus Operator Manual
- CDRL 12-9-22 Field Supervisor Manual

- CDRL 12-9-23 Non-Revenue Vehicle Manual
- CDRL 12-9-24 PSVRN System Administration Documentation
- CDRL 12-9-25 MTMS System Administrator Documentation
- CDRL 12-9-26 PSVRN Radio Dispatcher Manual
- CDRL 12-9-27 MTMS Radio Dispatcher Manual
- CDRL 12-9-28 Requirements Traceability Matrix
- CDRL 12-9-29 Options Documentation.

The Contractor is advised that the above list does not constitute all of the deliverables and submittals that may be required as part of this Project. The Contractor must include those CDRL items specified above either in whole or by reference, as part of the complete package of deliverables and submittals.

appendix **thirteen**

SFMTA Vehicle Inventory

appendix has been deleted

appendix **fourteen**

Required SFMTA User Work Stations & Licenses

for reference only

Revision History

Revision	Date	Change	Approval
0	12/04/2009	Release for RFQ/RFP	n/a

Dispatch Workstations and Consoles by Organizational Breakdown			1-Nov-09
Unit	**Variant**	**Operational Qty**	
Central Control (Lenox)			
Rubber Tire Dispatch and Train Control	1	11	
Theater Supervisor / Spare	1	1	
Senior Operations Manager (SOM)	2	1	
Superintendent	1	1	
Backup/Interim Control Center Readiness (1 SVN)	1	8	
Other Emergency Responders			
Outside Agency	4	1	
SFMTA Management and other indirect users	4	10	
Customer Service (311)	4	10	
Security/PoP Dispatch	1	2	
DPT Dispatch	4	2	
Cable Car			
Machinery	1	1	
Operations	1	1	
Stations and Wayside Booths			
Station Agents	4	15	
Station Operations and wayside booths	4	5	
Divisions			
Window Dispatch	4	8	
Towers (Potrero, Presidio)	1	5	
Meet and Greet (Woods, Flynn)	3	4	
Motive Power	3, 4	1	
Command Coach 9030	1	1	
SFMTA Radio Shop	1	1	
Supervisor notebook	4	20	
Training	1, 2, 3, 4	1	
Development Environment	1, 4	1	

Variant 1: Dispatch Workstation w/ Integrated Radio Console
Variant 2: Dispatch Workstation (no voice communications)
Variant 3: Fixed installed control stations
Variant 4: Web App (no voice communications, reduced functions)

appendix **fifteen**

Interface Control Document for Onboard Devices and the TransLink® Driver Console

Interface Control Document

for Onboard Devices

and the TransLink® Driver Console

Prepared for:

Metropolitan Transportation Commission

Prepared By:

Booz Allen Hamilton

Document No.: BAH-03-03-00001

April 29, 2004

Version 0.3

Document Approvals

Procedure Overview

Content	Description
Name	Interface Control Document for Onboard Devices and TransLink® Driver Console
Purpose	Describes the interface for data exchange between the ERG DC and other devices attached to the Primary and Auxiliary Communications Ports
Applicability	MTC TransLink® Project

Change History

Tracking Version No.	Date	Reason for Issue
0.1	02 Mar 2004	Initial draft based on meeting with operators
0.2	07 Apr 2004	Incorporated MTC editorial comments and added section on RS232 definition
0.3	27 Apr 2004	Incorporated MTC editorial and formatting comments

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Table 1: Acronyms and Abbreviations

Acronym	Meaning
ACK	Acknowledged
ACT	Alameda Contra Costa Transit District
AVL	Automatic Vehicle Location
AZDS	Automated Zone Detection System
CAD	Computer Aided Dispatch
CID	Card Interface Device
DC	TransLink® Driver Console
DVAS	Digital Recorders' Digital Voice Annunciation System
GGT	Golden Gate Transit
GPS	Global Positioning System
ICD	Interface Control Document
LAVTA	Livermore Amador Valley Transportation Authority
Long	Signed 4 byte variable (range –2,147,483,648 to
LSB	Least Significant Bit
MDT	Mobile Data Terminal
MID	Message ID
MTC	Metropolitan Transportation Commission
MSB	Most Significant Bit
NAK	Not Acknowledged
OSC	Orbital Science Corporation
PID	Parameter ID
TBD	To Be Determined
Ulong	Unsigned 4 byte variable (range of 0 to 4294967295)
Ushort	Unsigned 8 bit variable (range of 0 to 255)
VTA	Valley Transportation Authority

1.0 SCOPE

1.1 Purpose

This document provides the specification for the interface between the TransLink® Driver Console (DC) and other peripheral devices that either provide or require login, route change, or location information to other system devices. This document describes the framework to facilitate a single point of login on the vehicle between the pertinent devices. If possible, it will also provide a means to automatically transmit information to the other peripheral devices when trips change, i.e., if the data is keyed into the "controlling device" or is automatically generated by the "controller."

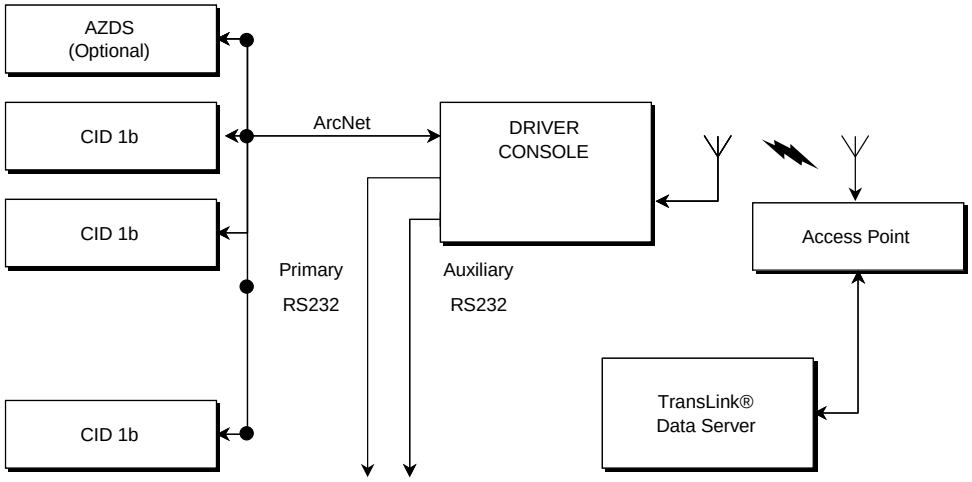
1.2 Overview

Phase II of the TransLink® program will be designed to allow the vehicle operator to input the login and route information via one device. This device will then transmit the login information to other peripheral devices. Vehicle operators currently log into the farebox and TransLink® DC. In some instances, they also log into an Orbital Sciences or Siemens Mobile Data Terminal (MDT) or a Digital Recorders Digital Voice Annunciation System (DVAS) MDT. This specification provides an interface where a vehicle operator can log into either the TransLink® DC or the MDT and the system will transmit the login information to the other attached devices. Additionally, when the vehicle operator selects a new route on the DC or the MDT detects a route change, the appropriate system (DC or MDT) will update the other devices automatically. In all cases, the chosen primary device will accomplish login and route changes, other devices will be peripheral to the primary device.

In all cases, there is the potential for the interconnection of a GFI, Cubic, or other manufacturer's farebox, where the farebox subsystems should be automated for login and route selection. There may also be a requirement to provide duplicate TransLink® transaction data to the farebox.

Exhibit 1 depicts the architecture for the TransLink® device, which includes the two RS-232 communication ports from the TransLink® DC: Primary and Auxiliary. The use cases and configurations to consider are documented in the following sections.

Exhibit 1: TransLink® System Architecture

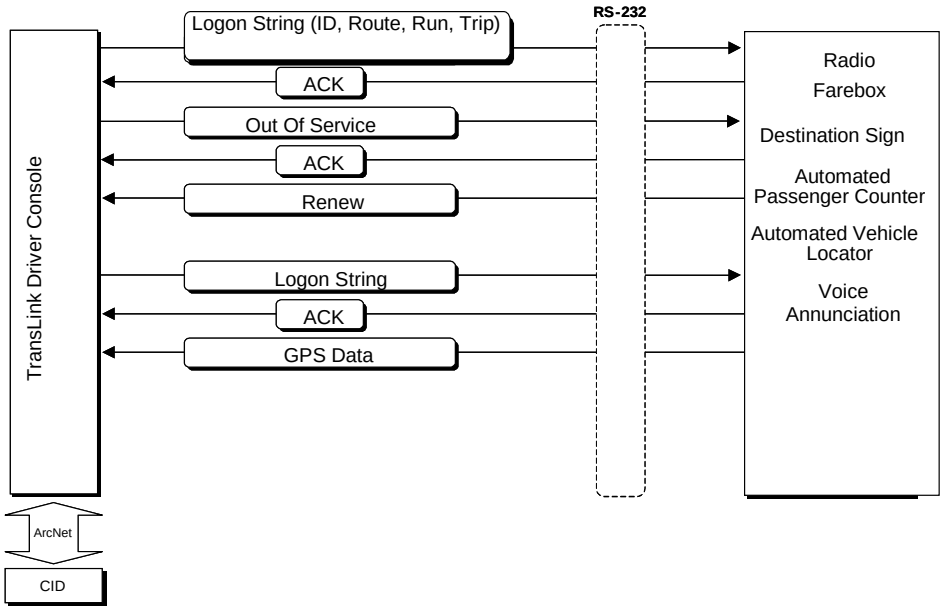


1.2.1 Use Case 1 – TransLink® DC as the Controller

In Use Case 1, the TransLink® DC is the controller and sends data to the other attached configured systems. The only exception in this use case is the implementation at Golden Gate Transit (GGT), which currently has a global positioning system (GPS) unit attached to the DC Primary communications port to provide location input for zone fare calculations.

Exhibit 2 depicts the typical data transfer for Use Case 1. The data transfer is similar for Use Case 2, as described in Section 1.2.2, however the login information is reversed.

Exhibit 2: Message Flow for Driver Console as Controller



The following bullets describe additional design requirements and features for Use Case 1.

a) In the GGT implementation, the GPS will remain tied to the Primary communications port using the protocol that is already established; the Auxiliary communications port should be configurable to allow login data, and/or transaction data to be passed to a farebox. The farebox would need to be modified to conform to this specification.

b) Should GGT procure a new computer aided dispatch/automatic vehicle location (CAD/AVL) system, the TransLink® DCs Primary port should be configured to accept login, route selection, and start/end trip messages, and GPS data from the CAD/AVL system per this specification format.

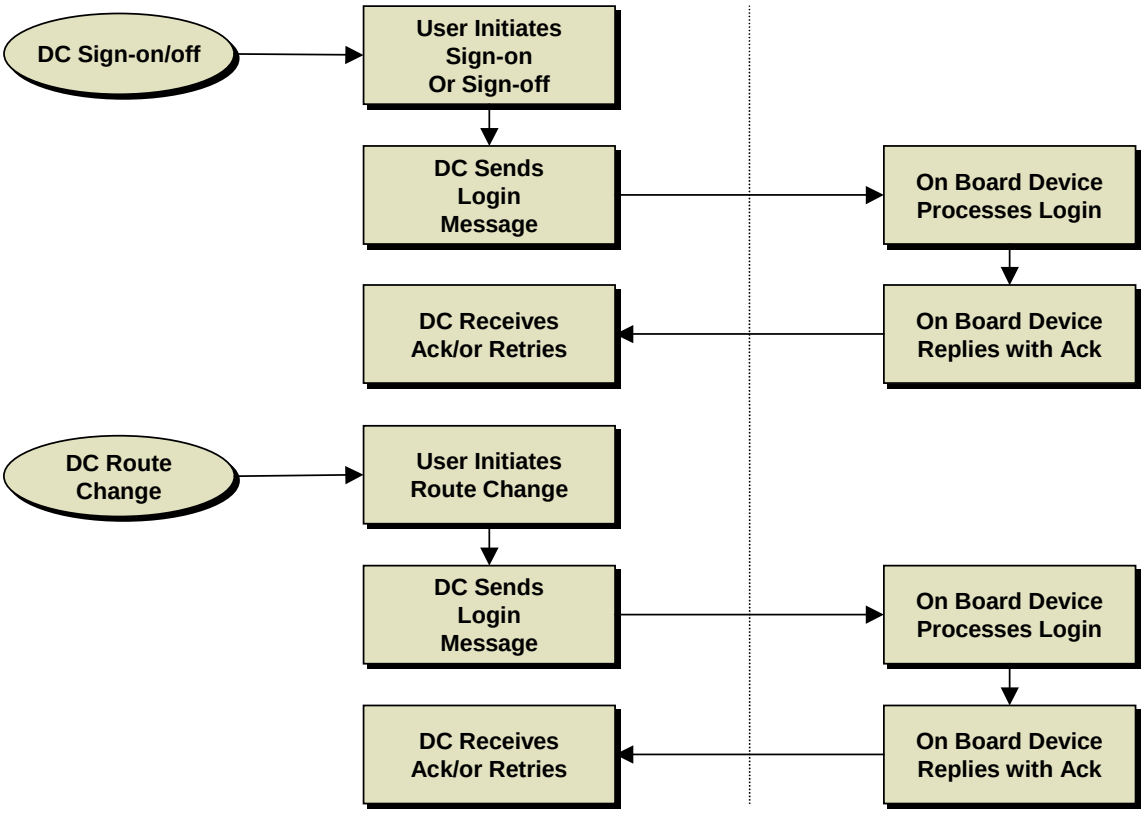
c) The Primary port shall be configurable to be used as an input for the GPS unit, such as the unit in use at GGT, or as an output for a peripheral device such as a farebox

d) The Auxiliary port of the DC shall be configurable for the data that is transmitted from this port, i.e., login data and no transaction data, login data and transaction data, transaction data and no login data, or no data.

e) When the vehicle operator logs into the DC, the DC shall transmit the login information to the DVAS system and the farebox. When the vehicle operator inputs a route change into the DC, the DC shall transmit the route information to the DVAS system and the farebox. Additionally, the DC shall transmit TransLink® transaction data to the farebox via the Auxiliary communications port based on the configuration set above.

Exhibit 3 below displays the message flow and transfer of data for Use Case 1.

Exhibit 3: Use Case 1 – Message Flow and Transfer of Data


DC Sign-on/off
User Initiates Sign-on Or Sign-off
DC Sends Login Message
On Board Device Processes Login
DC Receives Ack/or Retries
On Board Device Replies with Ack
DC Route Change
User Initiates Route Change
DC Sends Login Message
On Board Device Processes Login
DC Receives Ack/or Retries
On Board Device Replies with Ack

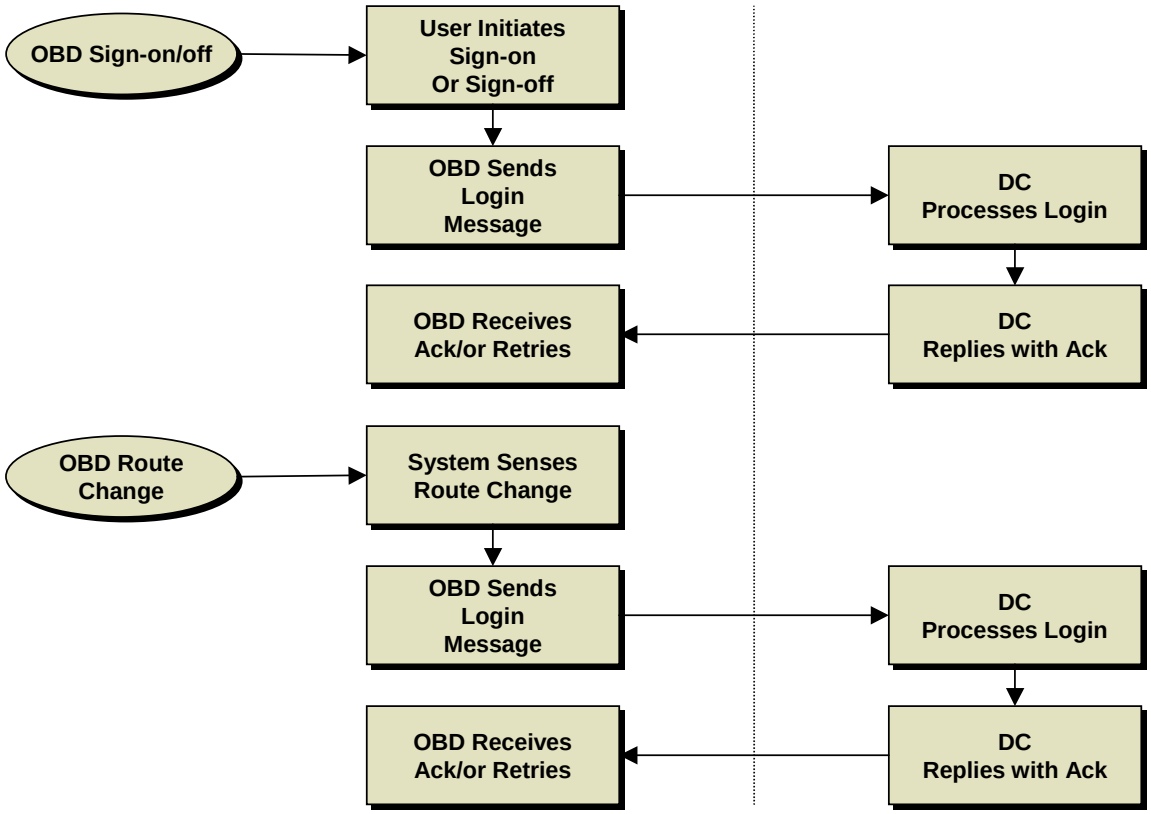
1.2.2 Use Case 2 – Other Devices as the Controller

In Use Case 2, the Digital Recorders DVAS, Orbital Sciences or Siemens MDT is the controller and can automatically transmit route information to other devices. In some applications, the Orbital Sciences MDT it is currently the controller for the farebox.

The vehicle operator logs into the MDT, which then provides the login information to the DC on the Primary communications port. The Auxiliary port is set up to transmit transaction information to the farebox. The transaction data is broadcast only without an acknowledgement of receipt message.

Exhibit 4 below displays the message flow and transfer of data for Use Case 2.

Exhibit 4: Use Case 2 – Message Flow and Transfer of Data



1.2.3 Operator Configurations for Phase II

Table 2 below defines the configurations for the Phase II operators. Not all operators may use all of the configurations, however, the currently unused configurations will likely be used by other transit agencies, as they are installed.

Table 2: DC Configuration Requirements

Configuration	Use Case	Primary Port	Auxiliary Port	Agency
1.1	1	Transmit Login/Route Change	Transmit Login/Route Change, Transaction Data	
1.2	1	Transmit Login/Route Change	Transmit Login/Route Change	
2.1	1	Receive GPS Messages	Transmit Login/Route Change, Transaction Data	GGT
2.2	1	Receive GPS Messages	Transmit Login/Route Change	
3.1	2	Receive Login/Route Change	Transmit Transaction Data	VTA, ACT, SamTrans,
3.2	2	Receive Login/Route Change		Muni

2.0 DC PHYSICAL INTERFACE

The pins in the DC cradle connector provide the physical interface for the DC. The table below defines the pin numbers.

Table 3: 16 Way Main Connector Pin Definitions

PIN No	SIGNAL DESCRIPTION
1	+24V BUS POWER – BATTERY POSITIVE
2	NOT CONNECTED
3	RELAY COMMON
4	MNT232TX
5	SIGNAL GROUND
6	ARCLAN2
7	PRIM232RX
8	AUX232RX
9	BUS GROUND – BATTERY NEGATIVE
10	CONTROL SWITCH (O/C OUTPUT)
11	RELAY N/O CONTACT
12	MNT232RX
13	ARCLAN1
14	PRIM232TX
15	AUX232TX
16	SIGNAL GROUND

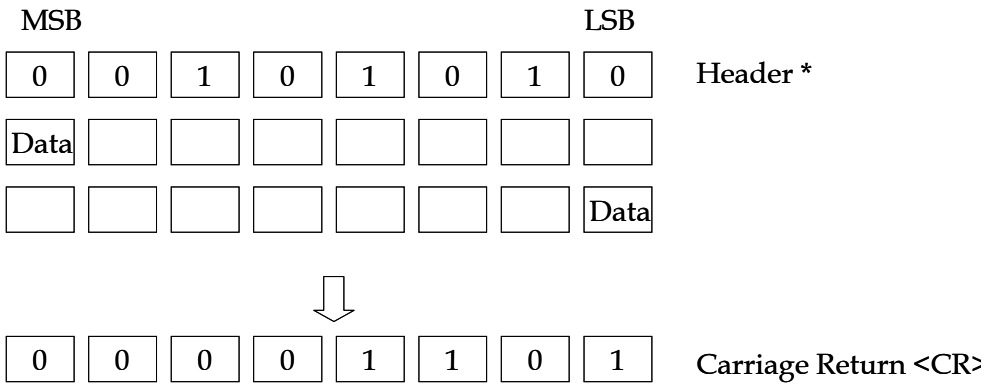
3.0 DATA EXCHANGE BETWEEN THE DC AND OTHER DEVICES

The following sections define the messages between the DC and other devices attached to the Primary and Auxiliary communication ports. Note, based on the use cases defined in Section 1, the DC may either generate or receive these messages, based on the configuration.

The system is a standard eight bit asynchronous, three wire RS-232C protocol (RxD, TxD, and GND). The system operates at 9600 Baud with no parity or flow control. There are eight data bits in each transmission. No stop bit is used.

The header is the first byte of each transmission, followed by the data detailed within the message type. The last byte of each message is the Carriage Return <CR>. Therefore the data for each message will be organized as detailed below:

Exhibit 5: Message Format



3.1 Message Overview

The following table shows an overview of the messages that are transmitted between the DC and Peripheral devices.

Table 4: Message Type Overview

PID	Sender	Intended Receiver	Message Type	Message Data	Message Timing
1	DC or MDT	DVAS Farebox DC (If Sender is MDT)	Login Route Change (if app.)	Driver ID Route # Route Dir Run # Block # Start/Stop Trip	▪ When the vehicle operator logs into the system ▪ At the start of every trip
2	GPS or MDT	DC	Location	GPS location coordinates	▪ As current system operates
3	Peripheral Device	DC or MDT	Acknowledgement	ACK/NAK	▪ Upon receipt of Login or Route Change Message, or Renew Message
4	Peripheral Device	DC or MDT	Renew	Renew request	▪ After a peripheral device reboots

3.2 Message Formats

The following subsections define the data exchange message formats. All multi-byte variables defined in the following messages are to be transmitted in the order of Most Significant Byte (MSB) to Least Significant Byte (LSB). Messages are formatted using a comma to delimit fields. The carriage return <CR> is the end of message delimiter. If a field is not changed by the message, then it should have no data in it.

3.2.1 Login and Route Change Message

When the vehicle operator logs into the vehicle in Use Case 1, via the DC, and in Use Case 2 through the MDT, the appropriate unit will transmit the login information to the peripheral devices. In each case, the login unit is responsible for the transmission of the information.

Devices such as the MDT typically consist of a Driver ID and Block or Run # login. If the login is in the garage and the vehicle is on a deadhead to the route start location, then there will be a configurable Route ID to identify the current service as a deadhead. A deadhead is defined as the non-revenue service portion either at the start or end of a block, or a section of non-revenue service between routes when a vehicle is interlining between two routes. For most subsystems, this is interpreted as “out of service”. When the vehicle commences at the route start location, it will need to send the login message with the Route # and Start Trip flag to initiate the subsystems on the proper service.

When a route changes, either on the DC in Use Case 1 or the MDT in Use Case 2, the unit initiating the change is responsible for the transmission of updated information to the peripheral devices.

Table 5 below presents the login message descriptions.

Table 5: Login Message Description

Field Name	Length (bytes)	Format	Description
Header	1	ASCII	*
MID	1	Ushort	Device Sending ID (TBD)
PID	1	Ushort	Message ID =’1’
Driver ID	4	Ulong	Numeric badge ID
Block #	4	Ulong	Numeric Block Number (9999,if not used)
Run #	4	Ulong	Numeric Run Number (9999,if not used)
Route #	5	ASCII	Route Number, pad unused characters with leading zeros, i.e., 00015, 0015X
Dir	1	Ushort	0 or 1 0 = Eastbound, 1 = Westbound 0 = Southbound, 1 = Northbound 0 = Loop
Start/Stop	1	Ushort	0 or 1 0 = Stop, 1 = Start
Delimiter	1	ASCII	Carriage Return <CR>

Sample messages are presented below:

MDT Login:

MID = 2

Driver ID = 1234
Block ID = 5678
Deadhead Parameter = 9999
Message: *2,1,1234,5678,,9999,,<CR>

At start of route 8 North:

Message: *2,1,,,,8,1,1<CR>

3.2.2 Location Message

The appropriate device, configured as the controller, will provide location information in the form of Latitude and Longitude. The frequency of this message can be configured from one message per second to one message every ten seconds.

The location message is included in this specification for growth purposes. It is not intended to redefine the current TransLink® messaging between the AZDS and the DC. This message is defined so that if a property that has an Orbital MDT, or similar system, wants to implement a zone based fare system, the Orbital MDT could pass the GPS information to the DC such that an AZDS would not be required.

Location messages are presented in Table 6.

Table 6: Location Message Description

Field Name	Length (bytes)	Format	Description
Header	1	ASCII	*
MID	1	Ushort	Device Sending ID (TBD)
PID	1	Ushort	Message ID = 2
Latitude	4	Long	Signed long integer Positive = North, Negative = South
Longitude	4	Long	Signed long integer with Positive = East, Negative = West
Delimiter	1	ASCII	Carriage Return <CR>

3.2.3 Renew Message

The Renew message is for a peripheral device that has rebooted or otherwise lost its operational information. This message is to be sent on power up from the peripheral device. The Renew message is acknowledged and followed by a Login and Route Change Data message. Table 7 below presents Renew message descriptions.

Table 7: Renew Message Description

Field Name	Length (bytes)	Format	Description
Header	1	ASCII	*
MID	1	Ushort	Device Sending ID (TBD)
PID	1	Ushort	Message ID = 3
Renew	1	Ushort	Device Sending ID (TBD)
Delimiter	1	ASCII	Carriage Return <CR>

3.2.4 ACK/NAK Message

The ACK/NAK message is used to acknowledge the receipt of a message of PID 1 or 3 only. The messages are acknowledged if they are properly received, and not acknowledged if they are incomplete. The sending device of a message of PID 1 or 3 will need to listen for an ACK and retry if one is not received within five seconds. Table 8 below presents the ACK message descriptions.

Table 8: ACK Message Description

Field Name	Length (bytes)	Format	Description
Header	1	ASCII	*
MID	1	Ushort	Device Sending ID (TBD)
PID	1	Ushort	Message ID = 4
PID ACK/NAK	1	Ushort	PID to ACK/NAK 1 or 3
ACK/NAK	1	Ushort	1 = ACK, 2 = NAK
Delimiter	1	ASCII	Carriage Return <CR>

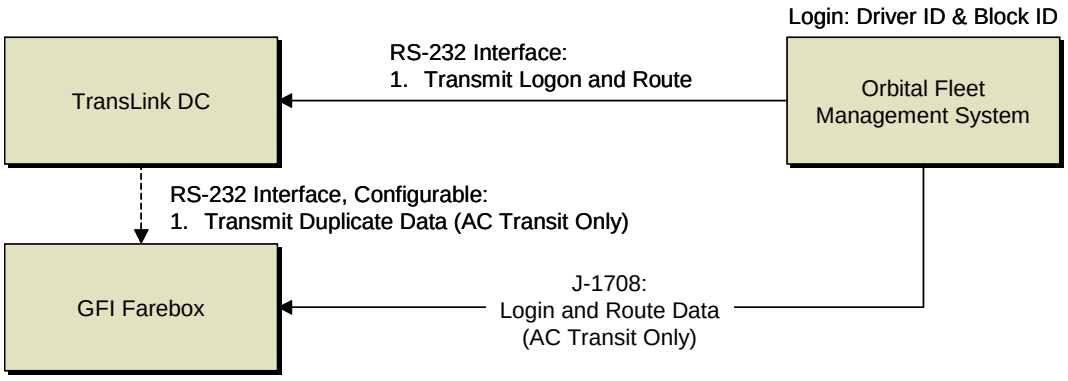
3.3 System Configurations

The following charts provide system diagrams detailing the current agency configurations planned for the operation of the interface.

3.3.1 AC Transit, SamTrans, and VTA

As shown in Exhibit 6, the Orbital MDT is the controller and is connected to the DC Primary communications port. The DC Auxiliary communications port connects to the farebox to exchange transaction data. Since several transit agencies do not want this functionality, the option to configure this port is a requirement. The Orbital MDT will be required to pass login (Driver ID), route/run selection (as appropriate), and start/end trip messages to the TransLink® DC, whether input manually by the vehicle operator or determined automatically by their system. Orbital will need to develop/modify software to enable this functionality. However, the development effort required should be very similar to that required for the J-1708 interface to the farebox at AC Transit that they bid and have completed in prior contracts.

Exhibit 6: AC Transit, VTA, SamTrans Configuration

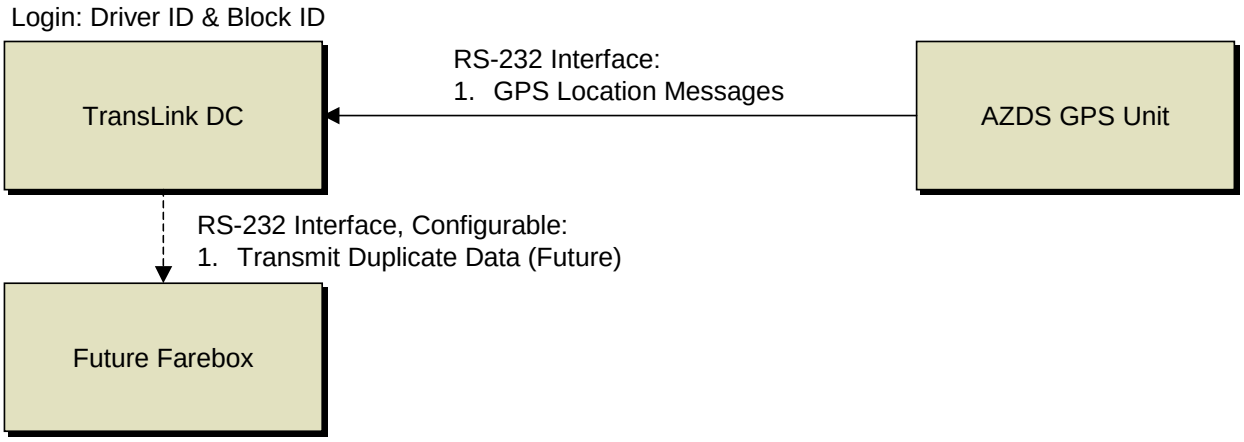


3.3.2 Golden Gate Transit

As shown in Exhibit 7, the DC is the controller and the GPS unit is connected to the Primary communications port. The DC will transmit login (Driver ID), route/run selection (as appropriate), and start/end trip messages to the farebox. GFI will need to develop/modify software to enable this functionality. The duplicate transaction data also should be configurable (On/Off) to the farebox.

GGT will be acquiring new fareboxes in the future. As such, GGT requires the option for the new fareboxes to be the central login device. Duplicate data will also need to be sent to the TransLink® DC.

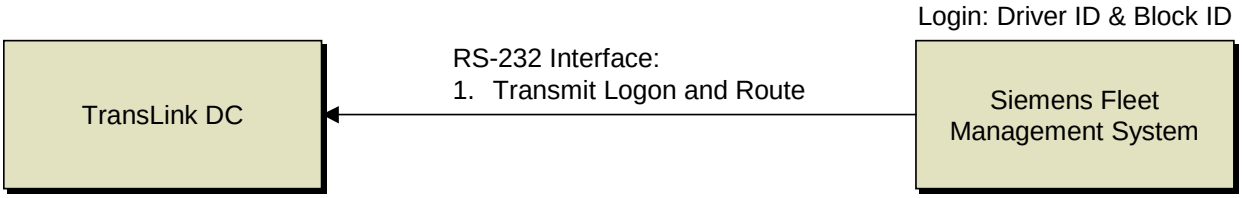
Exhibit 7: GGT Configuration



3.3.3 Livermore Amador Valley Transit Authority (LAVTA)

As shown in Exhibit 8, Siemens Fleet Management System is the controller and is connected to the Primary communications port. It is preferred that the Auxiliary communications port connects with a farebox for transaction data (the ability to configure this port to transmit or not is required since several properties do not want this functionality). Siemens will be required to pass login (Driver ID), route/run selection (as appropriate), and start/end trip messages to the TransLink® DC, whether input manually by the vehicle operator or determined automatically by their system. Siemens will need to develop/modify software to enable this functionality. However, the effort required should be very similar to that required for other interfaces they have done for both RS-232 and J-1708.

Exhibit 8: LAVTA Configuration

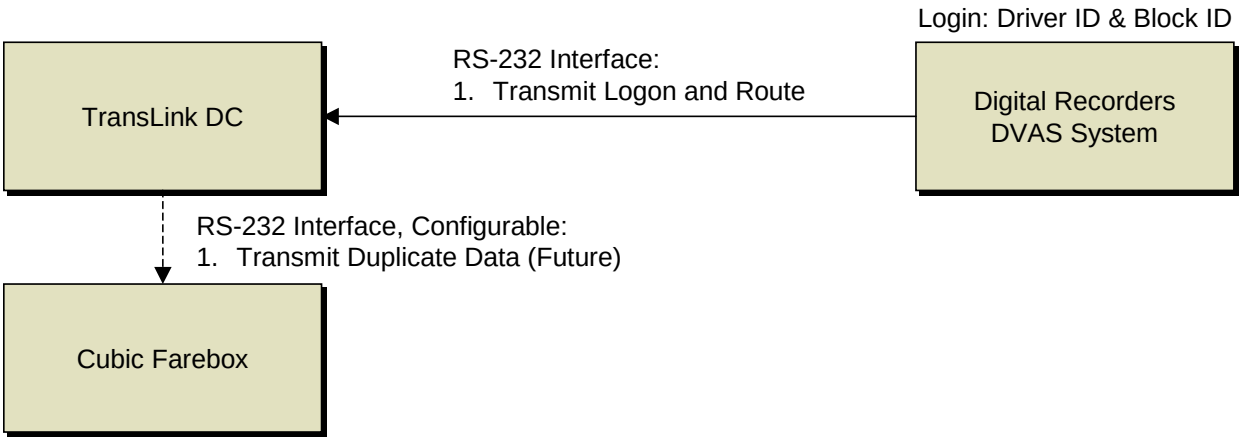


3.3.4 San Francisco Municipal Railway (Muni)

As shown in Exhibit 9, the Digital Recorders DVAS is the primary login since it can also determine the current route. DVAS is connected to the Primary communications port of the DC. DVAS also controls the Twinvision Sign. DVAS will transmit login (Driver ID), route/run selection (as appropriate), and start/end trip messages to the DC. Digital Recorders will need to

develop/modify software to enable this functionality. The Auxiliary communications port is configured to provide duplicate transaction data or is idle.

Exhibit 9: Muni Configuration



appendix **sixteen**

MTC 511.org Travel Info

for reference only

Real-Time Transit Information System

System Requirements
VERSION 2.7

Prepared for:

Metropolitan Transportation Commission

Prepared by:

Kimley-Horn and Associates, Inc.

June 8, 2009

DOCUMENT HISTORY

Document Description	Date	Version Number
First draft release of the System Requirements to MTC	April 27, 2007	1.2
Second draft release of the System Requirements	August 22, 2007	2.0
Third draft release of the System Requirements (released to TAC)	October 17, 2007	2.1
Fourth release of the System Requirements (internal review only)	March 12, 2008	2.1 revised
Fifth release (internal review only)	April 1, 2008	2.1 revised2
Sixth release (released to TAC)	April 14, 2008	2.2
Seventh release	October 9, 2008	2.3
Eighth release - deleted RTD Extraction Tool Requirements	March 2, 2009	2.4
Ninth release-added time clock synchronization requirement and stop ID minimum digit requirement	May 15, 2009	2.5
Tenth release – revised stop ID numerical prefix requirement	June 8, 2009	2.6
Eleventh release – added requirement for stops served by multiple agencies, added requirements for agency transfer application, and added suggestions for stop name standardization.	June 24, 2009	2.7

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REGIONAL REAL-TIME TRANSIT INFORMATION SYSTEM
SYSTEM REQUIREMENTS – VERSION 2.7

1. GUIDING PRINCIPLES 1

2. SYSTEM REQUIREMENTS 1

TABLE 1: SYSTEM REQUIREMENTS 4

1. GUIDING PRINCIPLES

For convenience, the set of guiding principles for the development, selection and implementation of the Regional Real-Time Transit Information System is provided below.

.

1. All data will be owned, shared, controlled and distributed as a regional asset amongst all participating stakeholders.
2. The system design, future upgrades and changes will be jointly determined by the MTC and participating stakeholder transit agencies.
3. Innovation will be planned and managed to mitigate risks, minimize equipment obsolescence, and maximize the system utility through the life-cycles of its component parts.
4. Application initiatives will be guided by established methodologies using an appropriately tailored systems engineering approach.
5. Technology infrastructure will be utilized and/or developed to facilitate integration and web-enabled services of data and systems.
6. The architecture shall utilize any existing communications infrastructure to the extent possible and feasible.
7. Secure network architectures will be employed.
8. Data and technology strategies will adhere to the National, State and Regional ITS Architectures, and federal ITS systems engineering practices to the extent possible.
9. IT systems will ensure recoverability to protect the integrity and continuation (up-time) of the system to the extent possible.
10. Open systems concepts will be leveraged to ensure portability, scalability, interoperability, and compatibility of the different systems.
11. Continuous process improvement strategies will be employed to improve the quality of the real-time transit information system over time.
12. The system and data exchange methodologies shall be based on standardized data formats and data structures, employing ITS recommended standards as applicable.
13. Technology strategies will be implemented which reduce maintenance efforts and enhance cost effectiveness.
14. Design strategies will be employed to maximize the potential for system expandability and migration to future systems.

These guiding principles will be continuously checked against any and all elements that formulate the Real-Time Transit Information System. This does not preclude revising these guiding principles to better suit the development of the System as the system requirements are further refined and decomposed and the system is implemented.

2. SYSTEM REQUIREMENTS

This section presents the system requirements for the Bay Area Regional Real-Time Transit Information System. These set of the requirements are based on the evaluation criteria developed for the selection of the architecture, discussions with the MTC, the TAC and Telvent Farradyne, and on the existing procedures and features of the existing real-time system. These requirements are primarily focused on the performance of the 511 System and the data transfers with the transit agencies. Also, these

requirements do not include the regional sign application requirements which are covered in a separate document.

The set of requirements are grouped according to the following areas and are color coded to reflect whether the requirement is a transit agency requirement (in red and bolded) or a 511 system requirement (in green).

1. General (GEN)
2. Interface (INT)
3. Predictions (PRED)
4. Configuration (CONF)
5. Logging (LOG)
6. Notifications (NOT)
7. Announcements (ANN)
8. System Backup and Archiving (ARCH)
9. Security (SEC)
10. Expansion (EXPN)

1. General (GEN)

These are the requirements that relate to the system wide or high level issues.

2. Interface (INT)

These are the requirements that relate to the standardization of the exchange of data between the transit agencies and the 511 System.

3. Predictions (PRED)

These are the requirements that include the performance metrics for the data exchange and response times between the transit agencies and 511 and internal processes within 511.

4. Configuration (CONF)

These are the requirements that relate to the definition, exchange and processing of the static configuration data from the transit agencies.

5. Logging (LOG)

These are the requirements that relate to the logging of events.

6. Notifications (NOT)

These are the requirements that relate to alarms and notifications for the system administrator to respond to.

7. Announcements (ANN)

These are the requirements that relate to the announcements to the 511 users under the alarm or notification scenarios.

8. System Backup and Archiving (ARCH)

These are the requirements that relate to the archiving of data for the system.

9. Security (SEC)

These are the requirements that relate to network security and user access privileges.

10. Expansion (EXPN)

These are the requirements that relate to expansion of the system.

The table (Table 1) below lists the requirements under each of the areas describe above.

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
G-001	The system shall be based on an open architecture including standardized interface definitions and communications protocols.	GEN	The system needs to have documented procedures, interfaces and protocols as necessary to allow system expansion and adding new transit agencies and their real-time systems.
G-002	The system shall not need any special or proprietary algorithms for the exchange, interpretation and dissemination of prediction and configuration data at the interface points.	GEN	The system needs to have documented procedures, interfaces and protocols as necessary to allow system expansion and adding new transit agencies and their real-time systems. Where proprietary elements are necessary, these elements shall not be at the interface points and shall not affect interoperability.
G-003	The system shall be able to operate unattended 24 hours a day, seven days a week.	GEN	The system shall be able to operate under normal conditions unattended by MTC and/or agency staff, except under conditions where manual intervention is necessary such as posting announcements on regional signs and troubleshooting.

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
G-004	**The system shall attain a reliability of 99.9% "up time" when predictions are being received by the 511 System from the transit agency systems (i.e., no more than 88 hours per year of downtime).**	**GEN**	**Need to track the hours that the system is unavailable for 511 users and for updating/transferring of prediction and/or configuration data. This data transfer should be tracked on an agency basis. Downtime is when the system is not available to 511 users for real-time predictions, i.e., the 511 system is unable to provide any predictions for any agency.**
G-005	The system shall include provisions for adding in levels of redundancy including server and database failover methods and processes.	GEN	A failover plan with redundant servers, databases and/or network redundancy is an option.
I-001	**Data exchange between the transit agency systems and 511 shall be performed using Java Messaging Service (JMS) unless the transit agency obtains MTC approval to use Web Services instead.**	**INT**	**The default data exchange mechanism will be JMS using a publish/subscribe model. The exception is to use bundling of predictions (see P-004)**
I-002	**If an agency uses JMS, MTC will provide the JMS client, which shall reside in an agency-owned workstation located on the agency's premises.**	**INT**	**The agency is still responsible for providing the prediction and configuration data to the JMS client.**
I-003	**If using JMS or web services, the JMS client or agency web server located at each transit agency's facilities shall utilize an existing Internet connection at the transit agency's facilities that is able to handle the transfer of prediction and configuration data to 511 for that agency.**	**INT**	**Should the existing Internet connection be deemed inadequate for the requirements set forth herein (i.e., due to data transmission latencies or bandwidth), a dedicated private wide area connection shall be used instead for the exchange of data between that specific transit agency's real-time system and the 511 System.**

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
I-004	**With Java Messaging Service (JMS), all prediction data shall be exchanged using a publish/subscribe model. The data exchange for configuration and arrived status data shall use a request/reply model.**	**INT**	**Configuration data and arrived status data will be requested of each agency at most once per day. Thus, this data can be exchanged using a request/reply model.**
I-005	**If a transit agency uses JMS, the system shall comply with the specifications as defined in the latest version of the *Extensible Markup Language (XML) Document Type Definitions (DTDs) for Java Message Service (JMS) Implementation***	**INT**	
I-006	**If using web services, all data (predictions, configuration data, and arrived status) shall be exchanged using a request/reply model.**	**INT**	**This requirement is intended to keep the transfer of configuration data, which are larger data files, away from the peak periods of usage of the 511 System.**
I-007	**If an agency uses web services, the agency's system shall comply with the specifications defined in the latest version of the *Extensible Markup Language (XML) Document Type Definitions (DTD) for Web Service Implementation.***	**INT**	
I-008	**Agency shall synchronize its system time clock with a reliable internet time source, such as time.windows.com. The time source shall synchronize the system clock at a minimum rate of once per day.**	**INT**	**The internet time source time.windows.com is preferred as it is the source with which the 511 system is synchronized.**
I-009	**The 511 Phone System shall store the DNIS that will be used by each transit agency that wants to have their calls automatically route to the departure times feature.**	**INT**	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
I-010	**The 511 Phone System shall check the DNIS of every incoming call BEFORE checking the ANI to determine if the call is from a 511 user.**	**INT**	
I-011	**If the DNIS belongs to a transit agency:** **- 511 will play a custom greeting indicating they are in the 511 Departure Times feature for their agency** **- The call will be routed to the Departure Times feature in the same manner as if the caller had requested a transit agency, then the Departure Times feature.** **- The caller will be asked for their Stop ID or to say "I don't know."** **- If the caller says "I don't know," they will NOT be asked their agency, and will only be allowed to select routes and stops for the agency from which they were forwarded.** **- After the first Stop ID request, regardless of whether any predictions are played, the caller shall be sent back to the top of the Departure Times feature and, if they say "I don't know" when asked for their Stop ID, they WILL be asked for their agency.**	**INT**	
I-012	**An additional report shall be created that totals the number of calls made by callers on each agency DNIS and the duration of those calls in minutes.**	**INT**	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
I-013	**Each agency that desires the DNIS-based call routing feature shall determine and install/configure a phone number/DNIS to be available for the feature. Agencies can either work with MTC to define a phone number/DNIS or use one of their own existing phone numbers.**	**INT**	
I-014	**When callers indicate to the agency operators that they want departure times information while using the agency phone system, the callers shall be forwarded to the assigned DNIS.**	**INT**	
P-001	The system shall collect *up to four predictions from the transit agencies, but* publish only the next *three* predictions per route/direction/stop combination for departure times of not more than 90 minutes.	PRED	The agencies shall send to 511 up to four predictions or as many as possible for each route/direction/stop combination and within the 90 minute prediction window. All predictions beyond 90 minutes shall be filtered out at the agency's end and not be sent to 511. 511 will only play up to three predictions.
P-002	The 511 system shall update any and all prediction data that is received from each of the transit agency systems within five (5) seconds of receipt of the prediction data.	PRED	All predictions received by 511 shall take no longer than 5 seconds to update the database.
P-003	**With publish/subscribe, the transit agency systems shall publish any and all generated predictions to 511 within five (5) seconds of the predictions being generated.**	**PRED**	**This is intended to minimize the time from when a prediction is generated by the transit agency to when 511 updates the predictions.**

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
P-004	**With publish/subscribe, bundling of predictions to send together will be allowed, if necessary, based on the transit agency's system. Predictions can be bundled and sent every thirty (30) seconds but not to exceed one minute.**	**PRED**	**There may be some cases where an agency will only be able to send a few predictions within a short time window. Thus, it may be more efficient to gather a few more predictions in longer time slices.**
P-005	**With request/reply, the transit agency systems shall send any and all generated predictions within five (5) seconds of the receipt of a data request from the 511 System.**	**PRED**	**This is intended to minimize the time between a request by 511 and a reply by the agencies.**
P-006	**All generated predictions shall be published/sent to 511 whether or not the actual predictions have changed.**	**PRED**	**The 511 System will perform the filtering of predictions when they are received by each agency.** **The 511 System takes the predictions and checks whether each prediction has changed. If a prediction has not changed, the time of update is changed based on the prediction timestamp. If a prediction has changed, the prediction and the time of update are both changed.** **511 views prediction updates on a route basis, not on a vehicle basis. Therefore, all predictions need to be sent so they stay in the same order in the data transfer file.**
P-007	Valid predictions (those that have already been filtered by the transit agency) for existing stops shall be sent on for dissemination to 511 users or to other transit agencies if subscribed for.	PRED	A valid stop is one with a Stop ID, Route ID and Route name in the 511 configuration database.

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
P-008	New predictions for an existing stop received from the transit agencies that have not changed from a previous prediction shall be filtered out and not sent to for dissemination to the 511 users. However, the updates to the timestamp of the prediction shall be updated for dissemination to 511 users or to other transit agencies if subscribed for.	PRED	The last time that the predictions have been updated are meant for the 511 users.
P-009	If a stop does not have a prediction, it shall be checked against the current list of stops that have predictions. If it is an existing stop, the updated times shall be changed. If the stop is new, it shall be marked as a new and inactive stop and a flag shall be sent to the configuration processor and the event shall be logged.	PRED	All stops in the database should have a current prediction unless there is a data exchange error. All new stops in the prediction data, but not in the configuration database shall be brought to the attention of the agencies. All logged events shall have a date and time stamp.
P-010	The system shall check new predictions against current predictions. If the difference between the two predictions is one minute or longer, the new prediction shall replace the current prediction. If not, the current prediction shall remain and the new prediction discarded. All new predictions shall be truncated off to the minute before comparing with the current prediction.	PRED	Current prediction times are truncated. The predictions need to be truncated off to the minute. Only if the minute changes will the predictions times need to be updated.
P-011	All predictions with Stop IDs, Route IDs and Route Direction that are not recognized (in the configuration database) shall be filtered out and not sent for dissemination to the 511 user or to other transit agencies. All filtered out predictions shall be logged.	PRED	All predictions without a valid stop shall be identified in order to determine whether or not a stop exists or whether there is an erroneous prediction. All logged events shall have a date and time stamp.
P-012	All predictions that have times in the past shall be filtered out and not sent for dissemination to the 511 users or to other transit agencies.	PRED	This filters out all outdated or stale predictions.

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
P-013	**All predictions published or sent from a transit agency to 511 shall be compressed (zipped).**	**PRED**	**The file(s) shall be zipped to minimize the size of the data to be transferred. The zipping of the files shall be the last action prior to the data transfer.**
P-014	**All prediction and configuration data that are published/sent from the transit agencies shall be delivered, received, processed, and made available to the 511 users by the 511 System in twenty (20) seconds or less; including all communications and processing time.**	**PRED**	**This time for the data transfer shall account for the zipping of files.**
P-015	The 511 system shall support response times of no longer than two (2) seconds for requests from 511 users and 511.org users for real-time prediction information	PRED	The requirement is to provide a response in 2 seconds and this may include announcements of any errors or lack of prediction data.

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-001	**The process for the implementation of major updates to an agency's configuration data shall conform to the following:** **1. The agency designates a single point of contact to coordinate with on any questions about proposed changes to the configuration data.** **2. The agency contact will copy the MTC contact on the e-mails that are being sent back and forth between the agency and their real-time vendor (if applicable) when going through the process of the getting ready for signups.** **3. The agency will notify the MTC contact when a test server (if applicable) is ready to be queried for updated configuration data transfer.** **4. MTC will query a test server (if applicable) to transfer the configuration data and compare the new configuration data with the existing configuration data and identify any changes. If a test server is not available, then the agency shall send a file containing the configuration data to MTC for testing on the 511 System's testbed server (see C-012)** **5. The transit agency and/or its real-time vendor will address and fix any questions or issues with the configuration data and proposed changes that will have substantial impacts on the 511 system. These fixes shall be done in a timely manner – see C-002.**	**CONF**	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-002	**The procedures called for under C-001 shall begin at least two weeks before a transit agency's sign-up or software change goes live to the pubic to ensure that new configuration data is ready for implementation on 511 a minimum of 48 hours prior to the changes going live by the agency.**	**CONF**	**This requirement is intended to have the 511 System Integrators verify the data formats of the configuration data in advance so should there be a need to make any modifications, these modifications can be completed and ready to go prior to the agency's changes going live.**
C-003	**When requested by the 511 System, the transit agency systems shall send the most current set of configuration data.**	**CONF**	
C-004	**The format of the configuration data, including any use of patterns, shall comply with the specifications as defined in the latest versions of the Extensible Markup Language (XML) Document Type Definitions (DTDs) for Java Message Service (JMS) Implementation and the Extensible Markup Language (XML) Document Type Definitions (DTD) for Web Service Implementation.**	**CONF**	**Two types of direction keys will be allowed, direction names or patterns. For those agencies who use patterns, they must also provide a mapping table to allow MTC to map from the pattern to a direction name that will be reported to the 511 users. The required mapping table format is referenced in the two documents referenced in requirement C-004.**

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-005	**All stop names provided to 511 from transit agencies shall not contain any non-alphanumeric characters. Permitted characters are alphabets, numbers, and underlines. Symbols are not permitted, such as "&".**	**CONF**	**To the extent possible, transit agencies should follow the following suggestions when defining stop names:** **- Use the same spelling, space usage, and capitalization for road names, station names, and stop names. For example, if there is a street called Sixth St., do not call it "Sixth St." in one stop name and "6th St." in another.** **- Avoid, if possible, using a numbered address for a stop location. If a stop is not at or near an intersection, use a landmark or business name as the location.** **- Use the post office abbreviations consistently for road suffixes. For example, for Street always use "St." Post office abbreviations can be found at: http://www.usps.com/ncsc/lookups/abbr_suffix.txt** **- For stops that are at or near an intersection of two roads, use the form "On Road: Cross Road." For example, Main St : River Rd indicates the stop is on Main Street and the nearest cross road is River Road. If this is not possible, the token between the two road names must be consistent on all stop names. Suggestions for tokens include "at" "and" "&" ";" "@" and "/"** **erent.**

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-005 (Cont.)			**- If there is a common alternate name for a stop, it should be placed in parentheses at the end of the name. An example is "Main St : River Rd (Train Station Parking Lot)." This form indicates the phrase "Train Station Parking Lot" will be recognized, but the stop name will be called Main Street at River Road.** **- Avoid special characters. Stop names should be strictly alphanumeric, with the exception of the colon ":" and parentheses "()" as discussed above.**
C-006	**Arrived status data for designated stops from a transit agency shall be provided once per day to the 511 System.**	**CONF**	
C-007	**Transit agencies shall use their internal numeric stop IDs as the real-time transit system stop ID for all public stop locations. For those agencies that use non-numeric characters for stop IDs for public stop locations, they shall convert these non-numeric stop IDs to numerics only. In the event an agency uses non-numeric stop IDs for non-production stops (stops not used by the public), these can be sent to the 511 System.**	**CONF**	
C-008	**Transit agencies shall utilize the real-time transit system for all stop ID postings at transit stops, other public notifications (e.g., websites) or marketing efforts.**	**CONF**	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-009	The 511 System shall perform quality control checks on the stop names and stop IDs provided by the transit agencies. The quality checks shall compare the existing and new set of stop names and stop IDs and identify any changes or differences. Any changes or differences shall be logged (see L-003).	CONF	
C-010	A new set of stop names and stop IDs shall be verified such that each stop name has an associated stop ID and that there are no duplicate stop IDs from an agency.	CONF	
C-011	**In the event that a transit agency provides the 511 System with duplicate stop IDs (same numeric value) for the same or different stop names, the 511 System shall flag these occurrences immediately during nightly configuration updates. MTC will work with the transit agency to resolve any such problems. The transit agency shall resolve the differences and provide the resolution to MTC at least 48 hours before a transit agency sign-up or within 48 hours if the configuration data is already live.**	**CONF**	
C-012	**The transit agencies' configuration data shall be made available to the 511 System's testbed server prior to going live with the data for each sign-up. (see C-001 and C-009)**	**CONF**	**This requirement will enable MTC to conduct tests on the new configuration data prior to going live.**
C-013	**The 511 System shall filter out all non-numeric stop IDs for non-production stops (stops not used by the public) and discard them.**	**CONF**	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
C-014	To prevent duplication of stop IDs between agency systems, a numerical prefix shall be used. Each agency will be assigned a unique numerical prefix which will consist of one or two digits. The prefix can either be added by the 511 system, or included as part of the stop IDs sent to the 511 System by the agencies. The combination of the agency's numeric stop ID and the numerical prefix will form the real-time transit system stop ID. The exception is that no prefix shall be added for BART stop IDs.	CONF	For those agencies with less than 1000 stops, a two digit prefix will be assigned, and for those agencies with 1000 stops or more a single digit prefix will be assigned. It is MTC's preference to keep the length of the stop IDs to a total of six digits or less including the unique agency prefix.
C-015	**All stop IDs provided to the 511 system without the numerical prefix shall be of two numerical digits or more.**	**CONF**	
C-016	**Directions for routes are optional. Should an agency provide directions for its routes, the names of the directions shall be such that the 511 caller will be able to recognize and use the direction name, e.g., inbound or loop.**	**CONF**	
C-017	**Stops served by multiple agencies will have multiple Stop IDs (one Stop ID per agency)**	**CONF**	**For example, if a stop is served by both Muni and Golden Gate, the stop will have one Stop ID for Muni predictions and a different Stop ID for Golden Gate predictions.**
L-002	The 511 system shall continuously and automatically monitor and log all error notifications that are published to the system administrator. This log of error notifications shall be kept for a minimum of one month. All logged events shall include date and timestamps.	LOG	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
L-003	The system shall automatically and manually generate reports of any and all changes to each transit agency's configuration data. All logged events shall include date and timestamps.	LOG	Reports are already being generated
L-004	The 511 system shall generate a notification and log the event automatically when a change in a transit agency's configuration data is identified. All logged events shall include date and timestamps.	LOG	
L-005	The 511 system shall be able to store log files of the predictions, on an ad-hoc basis, into a format which can be entered into a database and stored in a computer that is not accessible via the Internet. The log files shall be deleted after a configurable period of time. The specific data to be captured during the logging shall include: • Agency name; • Time of day; • Prediction (sent from agency); • Route; • Stop code; • Status field designating whether the 511 System registered a new prediction as either changed or unchanged since the last prediction received. The data shall be captured after it has been categorized by the 511 System.	LOG	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
L-006	**Transit agencies shall provide the capability to log the configuration, prediction and arrivals status data requests received from, and sent to the 511 System. Each log file entry shall be time stamped containing the date, hour, minute and seconds (optionally fractions of a second). Due to log file size concerns, agencies shall only be required to log requests and responses on an as-needed basis.**	**LOG**	
N-001	The 511 system shall send an e-mail to the system administrator and log the events within five (5) seconds upon identification of an error in messages or communications. All logged events shall include date and timestamps.	NOT	
N-002	With publish/subscribe, an e-mail shall be sent to the system administrator and the event logged if no data is received by all transit agencies for a period of five (5) minutes. All logged events shall include date and timestamps.	NOT	This requirement refers to a scenario where no data is received by any agency for a period of five minutes.
N-003	With publish/subscribe, an e-mail shall be sent to the system administrator and logged if no data is received by at least one transit agency for more than fifteen (15) minutes. All logged events shall include date and timestamps.	NOT	This requirement refers to no data being received by an, e.g., AC Transit, for a period of fifteen minutes. Data could still be received by other agencies within the fifteen minute period.
N-004	With publish/subscribe, an e-mail shall be sent to the system administrator and logged if an updated prediction for a stop is not received for more than 60 minutes. All logged events shall include date and timestamps.	NOT	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
N-005	With request/reply, an e-mail shall be sent to the system administrator and logged if an updated prediction for a stop is not received for more than 60 minutes. All logged events shall include date and timestamps.	NOT	
N-006	With request/reply, the 511 system shall send an e-mail to the system administrator automatically and log the event when requested *prediction data* from a transit agency is not available after a user-configurable number of request attempts. All logged events shall include date and timestamps.	NOT	
N-007	With request/reply, the 511 system shall send an e-mail to the system administrator automatically when requested *configuration data* from a transit agency is not available after a user-configurable number of attempts. All logged events shall include date and timestamps.	NOT	Currently, 511 requests configuration data once per day.
N-008	With request/reply, the 511 system shall send an e-mail to the system administrator automatically when requested *arrived status data* from a transit agency is not available after a user-configurable number of attempts. All logged events shall include date and timestamps.	NOT	
A-001	An announcement shall be presented to 511 users if no prediction data is available for a specific stop. This announcement shall be presented when the user specifically requests prediction data for a specific stop.	ANN	
Ar-001	The system shall have data archiving capabilities.	ARCH	

TABLE 1 – SYSTEM REQUIREMENTS			
ID	**Requirement**	**Allocation**	**Description**
Ar-002	Nightly backups of the databases for the 511 real-time transit information system shall be performed. The nightly backups shall be done for the configuration data, arrived status data and all logs, errors and notifications for each night and kept for 90 calendar days at a minimum. For prediction data, the nightly backups shall be kept for 14 calendar days at a minimum.	ARCH	The backed up data may be transferred to another medium (e.g., DVD), but all data shall be accessible by transit agency staff when requested for, and approved by MTC.
Se-001	**The system shall exchange data over secure network connections between the transit agencies and the 511 System.**	**SEC**	**If an Internet connection is utilized, a secure connection such as a virtual private network shall be used. Also the connections should be routed through agency firewalls and DMZs as deemed necessary by the agency for data security purposes.**
E-001	The system shall be designed such that the system can be expanded to include all the Bay Area transit agencies and all their routes, stops and fleets plus an additional 30% demand.	EXPN	This requirement is to accommodate the inclusion of additional transit agencies as the system grows over time.
E-002	The system shall be designed such that the system can be expanded to include the collection of data for continuous real-time reporting of transit vehicle position.	EXPN	This is a future requirement to potentially include AVL data for transit vehicle tracking.

Stop ID Prefixes	
Agency	**Prefix digit(s)**
Muni	1
WestCAT	2
Samtrans	3
Golden Gate Transit	4
AC Transit	5
SCVTA	6
Caltrain	70

appendix **seventeen**

Example: Coverage Test Plan

for reference only

SFMTA PSVRN

Coverage Acceptance Test Plan

September 2009

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This document is the final Coverage Acceptance Test Plan (CATP) for the San Francisco Metropolitan Authority (SFMTA) Public Safety Voice Radio Network (PSVRN) Communications System and supersedes and replaces Appendix xxx of the Request for Proposals (RFP) [RFP #].

1 PURPOSE

The CATP shall measure the voice coverage performance of the PSVRN, specifically, the radio frequency (RF) coverage being provided by the digital simulcast system that shall be installed under this project. The vendor and fmta shall conduct the Coverage Acceptance Test (CAT) in accordance with procedures identified in this CATP.

The CAT shall be composed of the tests listed in Appendix A. The vendor and SFMTA agree that the results of the tests identified in Appendix A shall be compiled, evaluated, and scored separately.

2 COVERAGE PERFORMANCE GUARANTEE

The vendor shall guarantee RF coverage performance in accordance with the requirements stated in Section 4.2 of this document.

If the RF coverage performance of the digital simulcast trunked radio system supplied by the vendor fails to meet the coverage requirements stated in this document, the vendor shall modify, or otherwise cause, the system to meet the minimum requirements of this document at no cost to SFMTA. If corrections to the system are required, SFMTA shall determine that all data collected previously to the correction shall be negatively impacted. As such, SFMTA shall require that the CAT tests be restarted at no cost to the SFMTA.

3 TYPES OF TESTS

The CATP consists of the following five (5) types of tests:

- *Bit Error Rate (BER)*—The BER is an automated test based on the BER of the talk-out signal. The BER test provides an accurate, repeatable, objective, and cost-effective method to verify voice coverage performance for the PSVRN simulcast systems. This test shall be accomplished on the above and below ground systems.
- *Receiver Signal Strength Indication (RSSI)*—The RSSI test is an automated test based on the signal strength of the talk-out signal. Like the BER test, the RSSI test provides an accurate, repeatable, objective, and cost-effective method to verify voice coverage performance for the PSVRN simulcast systems. This test shall be accomplished on the above and below ground systems.
- *Delivered Audio Quality (DAQ): Portable Outdoor Testing*—The DAQ test provides an evaluation of voice coverage performance under typical operating conditions within the specified defined service area (DSA). The in-building portion of the DAQ test provides an evaluation of the voice coverage performance inside randomly selected buildings within the coverage area.

- Delivered Audio Quality (DAQ): Critical Location —An additional DAQ test shall be accomplished for the pre-selected group of critical buildings identified in Appendix C. The test provides an evaluation of in-building voice coverage performance under typical operating conditions within each of these buildings. This test is more thorough than the random in-building test in that it requires a more comprehensive set of test points.

All of these tests are based on the standards established in TSB-88-C.

4 TEST METRICS

4.1 Defined Service Area (DSA)

The DSA defines the area by which a specific test shall be bounded. Two (2) DSA have been identified for the CATP. Appendix A specifies the DSA for each test. Appendix B specifies the boundaries of each DSA. The DSA shall be divided into a grid to allow for the efficient identification of test data. The CAT requires the test to be conducted in a manner to yield a statistical confidence level of 99 percent.

4.1.1 SFMTA Above Ground (DSA_A)

This DSA is bounded by the geopolitical boundary of the City and County of San Francisco (CCSF) plus Treasure Island and a portion of Marin County. This area is approximately 49 square miles.

4.1.2 SFMTA Underground (DSAU)

The DSA_U of the PSVRN is defined to be the underground stations, portals and tunnels of the SFMTA. The Cable Car Equipment rooms shall also be included in this DSA.

4.2 Coverage Requirements

The CAT shall verify that the service area reliability is 97 percent or greater within the DSA_U for mobile and portable underground coverage.

The CAT shall verify that the service area reliability is 95 percent or greater within the DSA_A for above ground coverage.

The CAT shall verify that all critical locations have a service area reliability of 95 percent, or greater, above ground or underground, as appropriate, coverage. Coverage at the critical locations identified in Appendix C is mandatory. Therefore, no specific building loss value shall be considered for these locations. The vendor shall provide a design that provides coverage at these locations that shall pass the CATP.

The vendor guarantees that the installed system shall meet the requirements identified within the RFP and the CATP. The vendor shall provide corrective actions to resolve any issues that caused the CATP failure at no cost to SFMTA.

4.3 Test Preparation

4.3.1 Test Start

Prior to commencement of coverage testing, the vendor shall certify to the SFMTA, in writing, that the system has passed the System Acceptance Test Plan (SATP) and the Operational Test. The SATP shall prove that the installed equipment is 100 percent operational, and that all components have been aligned, adjusted, and are ready for the CAT.

The Operational Test shall provide a burn-in period of thirty (30) days for the installed equipment. This test shall insure that the installed system is performing within stable and nominal parameters.

The vendor shall submit the written test results of the SATP to SFMTA, at a minimum, 2 weeks prior to the start of the CAT. Audits shall be required on those pieces of equipment, at a minimum, that require the following types of tests:

- The transmit frequency using a frequency counter
- The power into the antenna system using a power meter
- The antenna installation using a frequency-domain reflectometer (FDR).

4.3.2 Test Grid

4.3.2.1 Types of Test Areas

4.3.2.1.1 Grid

A test grid shall be established that extends over the areas described in Section 3.1. This grid shall be composed of tiles and sub-tiles.

4.3.2.1.2 Above Ground Tile

A tile shall bind an area of 0.5 X 0.5 mile. This shall yield a test grid consisting of approximately 214 tiles within the DSA_A.

4.3.2.1.3 Under Ground Tile

A tile shall bind an area no larger than 20 X 20 feet in non-train locations (i.e. stations or Cable Car equipment Rooms).

4.3.2.1.3 Tunnel Testing

4.3.3 Test Drive Route

4.3.3.1 Overview

A drive route plan shall be developed by the vendor and approved by the SFMTA to gather a collection of test points that shall be evenly distributed throughout a DSA and provide a statistically accurate determination of radio coverage performance.

The vendor shall maximize testing resources and combine all of the BER and RSSI tests into a single drive test drive, to the maximum extent possible.

4.3.3.2 Requirements

The vendor shall run multiple tests simultaneously on each test run to minimize the number of test runs. The same drive route shall be used for all tests identified in Appendix A, to the maximum extent possible.

The locations of each critical location shall be identified on the test grid.

The vendor shall develop a drive route map for each DSA depicted in Appendix A.

The drive routes shall follow established SFMTA routes.

Each DAQ test shall use a drive route that follows, as closely as possible, the automated drive route through the specific tile/sub-tile. This drive route shall serve as a guide for selecting test locations to establish outdoor and random in-building test point locations.

The drive route maps shall be supplied by the vendor to the drive test team(s). The test grid shall overlay the drive route map to provide reference points for the drive team.

The automated drive team shall be composed of one(1) representative from SFMTA and one representative from the vendor.

The DAQ drive team shall be composed of at least one(1) representative from SFMTA and one representative from the vendor. The SFMTA representative shall be a from operations.

The drive route shall consist of multiple test points to obtain sufficient statistics for the distribution of test locations within each test tile.

The drive route should pass through each tile once. However, the drive route may pass through selected tile a minimum of two(2) times. In addition, the route should pass through the central portion of the tile to the maximum extent possible.

The test route shall consist of the CCSF streets and byways (excluding tunnels and underground parking) and the SFMTA tunnels.

Vehicle velocity shall not exceed 60 miles per hour, or the speed limit, whichever is lower, to ensure an adequate number of test points over the measurement window within the tile.

4.3.3.3 Accessibility of Tiles

Some tiles may be inaccessible to the drive route. Only tiles accessible by rubber wheeled vehicles shall be considered. The vendor shall identify all of the inaccessible tiles on the drive route map. SFMTA shall review these inaccessible tiles to determine whether these will be excluded from the test.

4.3.3.4 Excluded Tiles

SFMTA shall determine any tiles that will be excluded from the CAT. Excluded tiles shall not be included in the test results. Any tile may be excluded from a test at the SFMTA's discretion.

Data collected while the test vehicle is in an excluded tile/sub-tile shall not be included in test calculations.

4.3.3.5 Presentation

The developed drive route shall be plotted using a resolution that will allow SFMTA to easily review and interpret the drive route test results. Different distinct colors shall be used to distinguish PASS/FAIL test points. The vendor shall also provide a map that shows PASS/FAIL/EXCLUDED tiles.

The vendor will submit the drive route map as a text file (*.txt) for input to MapInfo if requested by SFMTA. The data shall be provided to SFMTA in a format that allows for the direct import into MapInfo.

4.4 Test Equipment

4.4.1 Calibration Requirements

All test equipment shall be calibrated within 30 days prior to the start of the testing. All calibration documents shall be provided to SFMTA one (1) week prior to the commencement of testing. The calibration of the test equipment shall be accomplished by an independent calibration test facility. The calibration facility shall install no-tamper stickers on each piece of test equipment that was tested and calibrated.

4.4.2 Types of Automated Test Equipment

The vendor shall provide all mobile test equipment for the BER and RSSI measurements. Automated test measurements, using devices such as the Grayson Wireless Measurement System (WMS) or equivalent devices, shall be employed to perform the required test throughout the specified DSA's. The vendor's test equipment should have, at a minimum, the following characteristics:

- A Global Positioning System (GPS) receiver to provide accurate position information for each measured test point
- Industrial grade measurement receivers to provide Received RSSI Intensity (RSSI) data for a single or multiple sites
- Industry standard BER test equipment
- A roof-mounted antenna
- Capability for continuous recording of test points from multiple systems within the tile or sub-tile, at a sample rate of 350 or greater samples per 40λ.

4.4.3 DAQ Test Equipment

The test radios used for DAQ testing shall be randomly selected from the radios provided to SFMTA as part of this contract.

The radios delivered from the equipment stock shall be properly aligned and ready for operation, except for the radio specific information (i.e., channels, talk groups, ID number). Three (3) samples of six (6) radios shall be randomly selected from the radio stock. Each sample shall consist of different tiered radio (e.g. Tier 1). One (1) radio from each sample shall be randomly selected to be tested for proper alignment. If the radio fails, the vendor shall perform the appropriate alignment procedures to bring the radio to vendor's nominal performance criteria. The vendor shall select a second radio from the sample and perform the same testing to confirm the nominal performance of the radio. If the radio passes, then the remaining radios of the sample shall not be tested. If the second radio fails, the sample shall be set aside and a new sample shall be taken. The vendor shall analyze the failed sample to determine the cause of multiple failures. The vendor shall develop and implement a mitigation plan to correct these failures in the remaining radios that are in storage.

Once the radios have been confirmed to be operating within the vendor's performance parameters, each radio shall be programmed for radio specific information.

The vendor shall ensure that the radios are tested and meet the vendor's optimal performance criteria for the radio. The vendor shall provide SFMTA with the appropriate documentation showing that the radios have been properly aligned and calibrated two (2) weeks prior to the start of DAQ testing.

The vendor shall program the radios for the appropriate channels and talk groups for the test. Tier 1,2, and 3 radios with shoulder microphones (without shoulder microphone antennas) and belt clips shall be used for the test. Each radio shall be provided with a spare fully charged battery.

The testers shall wear the radios on their belt at hip level. Tests shall be performed using a shoulder microphone.

The test radios shall be randomly distributed each day to the test teams during the testing period. In addition, the test teams shall be provided with a second radio to use as backup and for administrative communications.

4.4.4 Test Vehicle

SFMTA shall provide transportation for the drive route testing and to any other test location that is not generally accessible by a car. The test vehicle shall be the standard non-revenue vehicle.

All data shall be collected with the test equipment mounted inside the test vehicle.

The mobile test antenna shall be the same antenna, and use the same antenna cable, that is being proposed by the vendor for vehicle installations. The antenna location on the test vehicle shall approximate the antenna location on a standard non-revenue vehicle.

The vendor shall provide to SFMTA any special test equipment accessories (e.g., power filters or antenna) or requirements for use of the test equipment within the test vehicle.

4.5 Data Collection

4.5.1 Overview

Data records collected during testing shall undergo post-processing in accordance with Appendix A. For each test, the minimum acceptable signal level at the antenna terminal is adjusted to the measurement reference point using the loss factors shown in Appendix A. A comparison shall be made between the mean measurement of the test point within a tile and this adjusted minimum level, denoted the *adjusted signal threshold*. Points that meet or exceed the adjusted signal threshold value shall be recorded as a pass, and those below the threshold shall be recorded as a fail.

To simplify the automated tests, only talk-back measurements shall be recorded. An analytical derivation of the relationship between talk-out and talk-back shall be included in the test report. The vendor shall describe the details of this analytical approach.

4.5.2 BER Data

The BER shall be calculated by transmitting from each radio system base station site a test signal in the ITU-T 0.153. The test equipment shall measure this signal at equidistant intervals throughout a specified interval of 40λ, or approximately 12 m (~40ft.). This sampling pattern shall be used throughout the entire drive route.

4.5.3 RSSI Data

RSSI is the amount of RF power being transmitted by the system that is received by a radio. An unmodulated carrier is transmitted on one selected channel. The test equipment shall measure this signal at equidistant intervals throughout a specified interval of 40λ, or approximately 12 m (~40ft.). This sampling pattern shall be used throughout the entire drive route.

4.5.4 DAQ Data

The tests shall be based on the DAQ of a test message. Each voice test shall be scored with a DAQ number of 1 to 5. The DAQ scoring shall be based on the following Bell System DAQ definitions:

- DAQ 5: Perfectly readable, negligible noise
- DAQ 4: Perfectly readable but with occasional noise
- DAQ 3: Readable with few syllables missing, requires occasional repetition
- DAQ 2: Readable with difficulty requires frequent repetition
- DAQ 1: Unusable, presence of speech barely discernible.

4.5.4.1 Above Ground Test

This DAQ test involves separate portable radio talk-out and talk-back tests within the specified DSA of the test. The DAQ test shall include one (1) test point within each tile to test outdoor portable coverage.

4.5.4.2 Under Ground Test

This DAQ test involves separate portable radio talk-out and talk-back tests within the specified DSA of the test. The DAQ test shall include one (1) test point within each tile to test under ground portable coverage. The tiles for the underground test shall be no smaller than 20 X 20 feet.

4.5.4.3 Critical Location Tests

The DAQ testing shall be accomplished at each of the locations identified in Appendix C. Prior to testing, SFMTA and the vendor shall develop a test plan identifying the location of each test call at each location.

4.5.5 Automated Data Test Points

4.5.5.1 Test Point Definition

A test point is the mean value of measured samples recorded over a 40λ interval. SFMTA desires a 99 percent confidence level that the recorded test point level is valid. In accordance with TSB-88B Table 24, the automated test shall record 350 samples over the 40λ interval. This sampling rate provides 0.50 dB True Value Accuracy at a 99 percent Confidence level.

4.5.5.2 Number of Test Points per Test Sample Area

The drive route shall allow for a minimum of 36 test points to be recorded per tile. The vendor shall identify each tile that does not meet this requirement. SFMTA reserves the right to exclude these tiles from the test.

4.5.6 Post-Processed Data Presentation

Data collected in an excluded tile shall not be plotted nor included in the test analysis.

The data records shall be plotted by the vendor on a clear film overlay, or equivalent electronic media, to the same scale as the drive route map. The plot shall clearly show the areas tested, any excluded areas, and all of the recorded test point values.

Different colors shall be used to represent different ranges of measured BER and RSSI test point values.

The overlay shall clearly depict passed tiles. The threshold value shall be printed within each tile.

The overlay shall present all failed tiles in the color red.

Tiles that are deemed by SFMTA to be inaccessible and not tested shall be presented in the color black.

Horizontal and vertical axes shall be numbered to facilitate the location of test tiles within the grid.

A table shall be provided by the vendor, in addition to the drive route maps, that identifies the testing results of each tile. The vendor shall provide these recorded test results to SAFMTA in a text file (*.txt). The table shall show, at a minimum, the following information for all tested tiles/sub-tiles—

- A grid identification number
- GPS location information
- All collected test point values for that tile
- The mean test point value for that tile
- The pass/fail status of that tile
- The total number of passed/failed tiles and the percentage of failed to pass tiles (no rounding of numbers).

The vendor may propose alternate approaches that use graphical information system software to accomplish this post-processed data presentation. However, the vendor is required to use the method prescribed within this CATP unless SFMTA agrees to changes in writing.

4.5.7 DAQ Test Points

4.5.7.1 Test Point Definition

A DAQ test point shall be defined as the team's PASS/FAIL determination for each test call accomplished in a tile during a DAQ test.

4.5.7.2 DAQ Test Point Failure Resolution

If the test members disagree regarding the PASS/FAIL status of a test call, a comment shall be recorded in the Test Log. During the DAQ post-test analysis, the BER sub-tile data for the test tile shall be reviewed to assist in resolving any DAQ test call disputes. SFMTA reserves the right to have the vendor provide additional analysis and mitigation actions to correct DAQ test point failures at no cost to SFMTA.

4.5.8 DAQ Data Post Processing

As part of the post-test analysis, the vendor shall compare the results of the DAQ test with the vendor's proposed coverage predictions. The test logs collected from the DAQ test shall be post-processed for each DSA by the vendor. The raw and processed data shall be provided to SFMTA as a text (*.txt) file. Test points that meet or exceed the DAQ criteria of the test shall be recorded as a PASS, and those below the threshold shall be recorded as a FAIL. The test points shall be plotted in accordance with Section 4.5.6. The test results shall not contain any significant groupings of failed tiles. Refer to Section 4.6.2 for testing and analysis of adjacent failed tiles.

4.5.9 DAQ Test Log

The vendor shall provide the mobile and dispatch test teams with a log for each DAQ test. These logs shall provide, at a minimum, the following information fields:

- Test point number
- Location name, floor and room number, if applicable
- GPS coordinates of test location, if applicable
- Description of test location (for in-building test points)
- Time and date of test
- Initials of testers
- Test score
- Comments
- Grid Number.

As part of the post-test analysis, the vendor shall compare the results of the DAQ test with the vendor's proposed coverage predictions. The test logs collected from the DAQ test shall be post-processed for each building. Points that meet or exceed the DAQ criteria shall be recorded as a PASS, and those below the threshold are recorded as a FAIL. Each test point in the building shall be annotated to indicate the result of the test.

4.6 PASS/FAIL Criteria

The vendor and SFMTA agree that failure to pass any of the in Appendix A constitutes a failure of the overall CATP. Furthermore, if the system fails automated testing, all acceptance tests shall cease until the automated test can be successfully retested. Failure of any of the test listed Appendix A shall require the vendor to identify and correct the cause of the failure and restart the CATP at no cost to SFMTA.

4.6.1 Tile

The mean of the test points within a tile shall be calculated and recorded as the threshold value for the tile. Test point values that equal, or exceed, the threshold value shall be recorded as a PASS, and those below the threshold shall be recorded as a FAIL. Appendix A identifies the threshold criteria for each tile and test.

4.6.2 Adjacent Failed Tiles

4.6.2.1 Overview

As part of the post-test analysis, the vendor shall compare the results of the drive test with the vendor's proposed coverage predictions. The test results shall not contain any significant groupings of failed tiles (i.e., clusters). No failed tile shall be adjacent to more than one other failed tile. The CAT shall fail if the test data depicts a cluster of tile(s) containing more than one adjacent failed tile(s) in either the horizontal, vertical, or diagonal orientation. The raw and processed data shall be provided to SFMTA as a text file (*.txt) to determine the magnitude of the failure.

SFMTA's interest is to identify and have the vendor correct any clusters that may be present in the system. SFMTA reserves the right to pass or fail the CATP based on the identification of a cluster.

4.6.2.2 PASS/FAIL Criteria

The post-analysis of the drive test data shall identify the PASS/FAIL status of all tested tiles. If any failed tile has more than one side adjacent to another failed tile, then a cluster of failed tiles shall be identified.

If a cluster is identified, further analysis shall be accomplished to determine the impact of the cluster of failed tiles on the service area coverage. The vendor shall be responsible for providing a mitigation plan to correct the cluster at no cost to SFMTA. The vendor is then responsible for retesting the cluster of failed tiles, as well as all other areas that may have been impacted by the vendor's mitigation plan, at no cost to SFMTA.

SFMTA reserves the right to PASS/FAIL the CATP based on the presence of a cluster.

4.7 Test Team

The automated and DAQ test teams shall be composed of SFMTA and vendor personnel.

Schedules and the number of SFMTA test personnel shall be provided to the vendor a minimum 10 calendar days prior to commencement of coverage testing to allow for setting up the logistics of the test (i.e., correct number of radios, vehicles).

Test consoles shall be staffed by experienced SFMTA dispatchers who will be dedicated 100 percent of their time to the performance of the coverage test.

The DAQ test shall be composed of the Mobile and Dispatch teams. Each team shall be composed of qualified and trained SFMTA and vendor personnel. The Dispatch team shall reside at the Dispatch Center location and initiate all calls from the Dispatch console. The Mobile team shall accomplish its testing in a SFMTA-provided vehicle as stated in Section 4.4.4.

The vendor shall provide DAQ test training to all personnel, SFMTA and vendor, performing the test. This training shall include, but not limited, the following information:

- DAQ voice quality demonstration
- Selection of testing locations within the building/locations
- Procedures for logging test results
- Procedures to log conflicting test results.

The DAQ training plan shall be presented to SFMTA at a minimum 2 weeks prior to the start of DAQ testing

4.8 SYSTEM OR EQUIPMENT MALFUNCTIONS

SFMTA and the vendor agree that the intent of the CAT portion of the CATP is to test coverage and not individual system components. Therefore, the following procedures apply:

- The vendor and SFMTA agree that, in the event of a component failure in the system or test equipment that adversely affects the coverage test process, the coverage test shall be suspended until the system component or test equipment is restored to normal operation. Any such corrective action shall be done under the supervision of the vendor's Site Manager or his/her designee in coordination with the SFMTA Project Manager. The vendor shall provide and implement the remedy to correct the failure at no cost to SFMTA. After correction of the failure, the CAT shall restart at the beginning of the test phase.
- The vendor and the SFMTA agree to discuss the potential impact of the aforementioned failure(s) on individual tests, which may have been conducted during the time the system or test equipment was malfunctioning, to determine whether the affected tests (if any) should be redone. The vendor shall accomplish all tests that may require retesting as a result of the failure at no cost to SFMTA.
- During the coverage testing period, the vendor agrees that maintenance, repair work, or adjustments to the system SHALL NOT BE PERMITTED unless specifically authorized by the vendor Site Manager and SFMTA Project Manager.

The vendor's Site Manager shall authorize any maintenance that is necessary for the upkeep of the system. SFMTA representatives are encouraged to accompany the vendor personnel at all times.

4.9 SIMULCAST OPTIMIZATION TEST DATA COLLECTION

For each test listed in Appendix A, the measured levels and estimated times of arrival of the signals from the simulcast sites shall also be compared at each measurement point to determine areas with excessive time delay interference (TDI). In addition to failures based on insufficient signal level as stated in the previous sentence, a simulcast system measurement point shall also fail if the signal levels from two or more sites differ by less than the defined capture threshold *and* have a time of arrival difference greater than the time differential threshold. Values for capture and time differential thresholds for the proposed design are 15 dB and 36 μsec, respectively. The vendor, at no cost to SFMTA, is responsible for remedying all such deviations.

5 COVERAGE ACCEPTANCE TEST (CAT)

5.1 BER TEST

Radio coverage shall be verified by measuring talk-out (base-to-mobile) BER throughout the DSA for each test, as specified in Appendix A, and calculating the threshold of each tile that exceeds the required BER level for acceptable performance.

The test shall be considered to pass if this percentage of passing test tiles equals, or exceeds, SFMTA's minimum requirement for area coverage within the DSA.

Test values shall be reported with a precision of a tenth of a percent. Rounding up to whole number values shall not be allowed.

5.2 RSSI TEST

Radio coverage shall be verified by measuring talk-out (base-to-mobile) RSSI throughout the DSA for each test, as specified in Appendix A, and calculating the threshold of each sub-tile that exceeds the required RSSI level for acceptable performance.

The test shall be considered to pass if this percentage of passing test tiles equals or exceeds SFMTA's minimum requirement for area coverage within the DSA.

Test values shall be reported with a precision of a tenth of a percent. Rounding up to whole number values shall not be allowed.

5.3 DAQ TESTING

DAQ tests listed in Appendix A shall be performed using the digital mode of the portable radio at all test points within the specified DSA of the individual test.

5.3.1 Portable Above Ground

The DAQ above ground test threshold, as stated in Appendix A, is defined as the RF signal strength that is present at the subscriber unit antenna, including an 12.4-dB body loss at the hip.

The above ground DAQ test shall be accomplished in every accessible test grid.

The tester shall perform the test call from within the test vehicle. The radio shall be worn at the hip of the tester. All test calls shall be accomplished using a shoulder microphone. If a tile is inaccessible by a vehicle, SFMTA shall advise the test team regarding the best method to accomplish the testing within the tile.

The test call shall not be initiated from within tunnels or underground parking decks.

5.3.2 Portable Under Ground

The DAQ under ground test threshold, as stated in Appendix A, is defined as the RF signal strength that is present at the subscriber unit antenna, including an 12.4-dB body loss at the hip.

The under ground DAQ test shall be accomplished in every tunnel and assessable station. The SFMTA and the vendor shall identify which sections of the stations shall be tested.

The tester shall perform the test call from within the train or on foot in the stations. The radio shall be worn at the hip of the tester. All test calls shall be accomplished using a shoulder microphone. If an area is inaccessible, SFMTA shall advise the test team regarding the best method to accomplish the testing within the tile.

5.3.3 Portable Critical Locations

The DAQ critical location test threshold value, as stated in Appendix A, is defined as the RF signal strength at the subscriber antenna including the body loss. SFMTA requires communications at all of the critical locations. The vendor's design must accommodate the specific building loss at each critical location, if applicable.

5.3.4 Null Test Points

In complex urban radio systems, nulls are often encountered. A null coverage area is usually the result of reflected signal paths coming together in unpredictable ways causing one signal to cancel another. There is no method to predict the location of a null point. A lack of sufficient RSSI would be the first indication to the test team that a null had been encountered. If this occurs, the test team shall be allowed to move three (3) feet in any direction and attempt the test a second time. The failure of the first call shall be annotated on the test sheet. The test call shall be successful if the second call passes.

5.3.5 Test Call Procedure

Each DAQ test team shall inform the Dispatch Center that it is ready for a test call. The test radio shall be worn at the hip of the test team member making the test call. The Dispatch team initiates the test by making a call to the test team. The test team shall respond with the shoulder microphone. After the call is completed, the members of both test teams shall evaluate the voice quality of the call and log the results into the test log book.

The test team shall make test calls on the digital system at each above ground and under ground test point.

5.3.5.1 Test Call Steps

A standardized test form shall be completed for each test location. Testers shall use phonics when calling out alphabetic symbols (i.e., “a” is alpha). For numeric strings each individual number shall be called separately. The following is the DAQ Test Procedure for analog and digital voice:

- The tester with a portable radio located at the hip shall initiate the test call by notifying the Dispatch team that he/she is ready to proceed. If the tester cannot contact the Dispatch Team, he/she shall relocate to a position within three (3) feet and attempt a second call. If the tester cannot contact the Dispatch team, he/she shall exit the building and attempt to establish contact to the Dispatch team. The site shall be graded a failure.
- The Dispatch team shall begin the test call for test point.
- The dispatcher shall acknowledge the call using the tester’s unit number (e.g., 2246).
- The tester shall transmit an inbound test message (e.g., Test Number 3245.1A, 12, 42, 57, 14, 88).
- The dispatcher shall transmit the outbound test message (e.g., 13, 47, 39, 99, 11).
- The tester shall sign off.
- If human error or distraction causes a transmission to be missed, the test sequence shall be repeated and not be recognized as an attempt.
- After all test cycles are completed, the standardized test forms shall be tabulated and scored.

5.3.5.2. Above Ground Test Call Procedure

The test team shall identify a location for a test point. The test point should be centrally located within the test grid. The test team shall identify the location by its GPS coordinates. The GPS unit used in the BER/RSSI testing may be used to obtain the GPS coordinates. Other GPS devices with similar accuracy specifications may be used. The test location shall be logged onto the test sheet.

5.3.5.3 Critical Location Test Call Procedure

The test team shall identify a location for the test call. The test point should be located in a general access area within the building. Multiple test calls shall be made within the location.

In buildings that are not equipped with bi-directional amplifier (BDA) systems, at a minimum, five (5) test points per floor shall be accomplished. The test team shall not locate test points in areas that are surrounded by substantive structures, such as x-ray rooms, basements, or stairwells.

In buildings that have BDA systems installed, the test team shall test to verify the operation of the BDA system. SFMTA and the vendor shall identify the test locations based on the design of the BDA system. The test location shall be logged on the test sheet. The test sheet shall have a floor plan or diagram of the test location. The test team shall mark and annotate the drawing for each test call made.

Appendix A—Radio Service Areas and Signal Levels

SYSTEM	CATP REQUIREMENT	BOUNDARY	RADIO TEST	TEST CONDITION	TEST TYPE	NUMBER OF TEST POINT	BODY LOSS (dB)	BER Threshold	SERVICE AREA RELIABILITY (%
Digital Simulcast	REQUIRED	A	PORTABLE	Above ground	BER	4	12	2.00%	95
	REQUIRED	A	MOBILE	Above ground	BER	4	12	2.00%	95
	REQUIRED	U	PORTABLE	Under ground	BER	4	12	2.00%	97
	REQUIRED	U	MOBILE	Under ground	BER	4	12	2.00%	97
	REQUIRED	A	PORTABLE	Above ground	DAQ	1	12		95
	REQUIRED	U	PORTABLE	Under ground	DAQ	1	12		97
	REQUIRED	C	PORTABLE	CRITICAL LOCATIONS	DAQ	1	12		95

Note:

1 A = DSA for above ground
2 U = DSA for under ground
3 C = Critical locations

Appendix B—DSA Maps

Appendix C—Critical Locations Listing

Critical Locations List

FACILITY	ADDRESS

appendix **eighteen**

Radio Licenses

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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SAN FRANCISCO, CITY AND COUNTY OF

ATTN: WAI C. TOM
SAN FRANCISCO, CITY AND COUNTY OF
700 PENNSYLVANIA AVENUE
SAN FRANCISCO, CA 94107

Call Sign	File Number
WQKE739	0003789143

Radio Service
YE - PubSafty/SpecEmer/PubSaftyNtlPlan,806-817/851-862MHz,Trunked

Regulatory Status
PMRS

Frequency Coordination Number
09012813058888

FCC Registration Number (FRN): 0001550318

Grant Date	Effective Date	Expiration Date	Print Date
04-21-2009	04-21-2009	04-21-2019	04-22-2009

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 2 **Address:** CORNER OF CLAY AND JONES
City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA
Lat (NAD83): 37-47-35.0 N **Long (NAD83):** 122-24-50.9 W **ASR No.:** **Ground Elev:** 103.0

Loc. 3 **Area of operation**
Operating within a 50.0 km radius around fixed location 2

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
2	1	000854.23750000	FB8	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	150.000	150.000	97.0	176.0	04-21-2010
3	1	000809.23750000	MO8	100		20K0F1D 20K0F3E 8K10F1D 8K10F1E	100.000	100.000			04-21-2010

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Reference Copy

Licensee Name: SAN FRANCISCO, CITY AND COUNTY OF

Call Sign: WQKE739 **File Number:** 0003789143 **Print Date:** 04-22-2009

Control Points

Control Pt. No. 1

Address: 875 STEVENSON

City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA **Telephone Number:** (514)337-2251

Associated Call Signs

Waivers/Conditions:

Authorized by waiver of Rule 90.621(b) granted 4/20/09.

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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SAN FRANCISCO, CITY AND COUNTY OF

ATTN: WAI C. TOM
SAN FRANCISCO, CITY AND COUNTY OF
700 PENNSYLVANIA AVENUE
SAN FRANCISCO, CA 94107

Call Sign	File Number
WQKE988	0003799924

Radio Service
YE - PubSafty/SpecEmer/PubSaftyNtlPlan,806-817/851-862MHz,Trunked

Regulatory Status
PMRS

Frequency Coordination Number
09040717061090

FCC Registration Number (FRN): 0001550318

Grant Date	Effective Date	Expiration Date	Print Date
04-24-2009	04-24-2009	04-24-2019	04-25-2009

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Address:** CHRISTMAS TREE POINT
City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA
Lat (NAD83): 37-45-16.7 N **Long (NAD83):** 122-26-47.9 W **ASR No.:** **Ground Elev:** 261.5

Loc. 2 **Address:** CORNER OF CLAY AND JONES
City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA
Lat (NAD83): 37-47-35.0 N **Long (NAD83):** 122-24-50.9 W **ASR No.:** **Ground Elev:** 103.0

Loc. 3 **Area of operation**
Operating within a 50.0 km radius around fixed location 1

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000854.11250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	57.0	292.0	04-24-2010

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Reference Copy

Licensee Name: SAN FRANCISCO, CITY AND COUNTY OF

Call Sign: WQKE988 **File Number:** 0003799924 **Print Date:** 04-25-2009

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000854.31250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	57.0	292.0	04-24-2010
1	1	000854.38750000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	57.0	292.0	04-24-2010
1	1	000854.46250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	57.0	292.0	04-24-2010
2	1	000854.11250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	97.0	176.0	04-24-2010
2	1	000854.31250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	97.0	176.0	04-24-2010
2	1	000854.38750000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	97.0	176.0	04-24-2010
2	1	000854.46250000	FB2	1		20K0F1D 20K0F3E 8K10F1D 8K10F1E	200.000	400.000	97.0	176.0	04-24-2010
3	1	000809.11250000	MO	100		20K0F1D 20K0F3E 8K10F1D 8K10F1E	100.000	100.000			04-24-2010
3	1	000809.31250000	MO	100		20K0F1D 20K0F3E 8K10F1D 8K10F1E	100.000	100.000			04-24-2010

Reference Copy

Licensee Name: SAN FRANCISCO, CITY AND COUNTY OF

Call Sign: WQKE988 **File Number:** 0003799924 **Print Date:** 04-25-2009

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
3	1	000809.38750000	MO	100		20K0F1D 20K0F3E 8K10F1D 8K10F1E	100.000	100.000			04-24-2010
3	1	000809.46250000	MO	100		20K0F1D 20K0F3E 8K10F1D 8K10F1E	100.000	100.000			04-24-2010

Control Points

Control Pt. No. 1

Address: 875 STEVENSON

City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA **Telephone Number:** (514)337-2251

Associated Call Signs

Waivers/Conditions:

Prior to commencing operations on any channel or channels specified under this authorization, the licensee must provide at least 60 days written or electronic notice to Sprint Nextel Corporation that it intends to activate the channel(s) for testing or commencement of operations. Sprint Nextel must cease operation on the channel(s) specified in the notice by the intended date to the extent necessary to comply with the co-channel spacing requirements of 90.621(b), after which the licensee may activate the channel(s). Sprint Nextel Corporation has established an email box to receive these notifications at 800mhzinterleavedspectrum@sprint.com.

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Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

LICENSEE: SAN FRANCISCO, CITY AND COUNTY OF

ATTN: MUNICIPAL RAILWAY CHRISTOPHER HILL
SAN FRANCISCO, CITY AND COUNTY OF
1201 MASON ST
SAN FRANCISCO, CA 94108

Call Sign	File Number
WNXR204	0000638921

Radio Service
GP - Public Safety/Spec Emerg, 806-821/851-866 MHz, Conv.

Regulatory Status
PMRS

Frequency Coordination Number

FCC Registration Number (FRN): 0005516281

Grant Date	Effective Date	Expiration Date	Print Date
10-25-2001	10-25-2001	11-01-2011	

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 **Area of operation**
Land Mobile Control Station meeting the 6.1 Meter Rule: CA

Loc. 2 **Address:** CLAY JONES BLDG 1250 JONES ST
City: SAN FRANCISCO **County:** SAN FRANCISCO **State:** CA
Lat (NAD83): 37-47-34.7 N **Long (NAD83):** 122-24-50.9 W **ASR No.:** **Ground Elev:** 115.0

Loc. 3 **Area of operation**
Operating within a 113.0 km radius around fixed location 2

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	000810.23750000	FX1	1		20K0F3E	15.000	15.000			
2	1	000855.23750000	FB2	1		20K0F3E	75.000	35.000	97.0	77.0	
3	1	000810.23750000	MO	45		20K0F3E	2.000	2.000			

Conditions:
Pursuant to §309(h) of the Communications Act of 1934, as amended, 47 U.S.C. §309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. § 310(d). This license is subject in terms to the right of use or control conferred by §706 of the Communications Act of 1934, as amended. See 47 U.S.C. §606.

Reference Copy

Licensee Name: SAN FRANCISCO, CITY AND COUNTY OF

Call Sign: WNXR204 **File Number:** 0000638921 **Print Date:**

Antennas

Loc No.	Ant No.	Frequencies (MHz)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
3	1	000855.23750000	MO	45		20K0F3E	2.000	2.000			

Control Points

Control Pt. No. 1

Address: 1201 MASON ST

City: SAN FRANCISCO **County:** **State:** CA **Telephone Number:** (415)292-2051

Associated Call Signs

Waivers/Conditions:

NONE

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appendix **nineteen**

Radio Traffic Analysis Report

for reference only

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

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APPENDIX A: PEAK BUSY HOUR AIRTIMES - BY CHANNELS & HOUR OF THE DAY

SECTION 1. BACKGROUND

The San Francisco Municipal Transportation Agency (SFMTA) has contracted with Booz Allen Hamilton (Booz Allen) to provide Professional Engineering Services for the Radio System Replacement Project under SFMTA Contract CS-139. This report is part of the set of contract deliverables provided by the Booz Allen team.

SECTION 2. PURPOSE

The purpose of this report is to baseline SFMTA's current wireless communications traffic on the various voice radio channels, estimate future growth and to establish future traffic capacity requirements.

SECTION 3. SYSTEM LOADING AND CAPACITY

A traffic study was conducted to verify the perceived level of airtime traffic on SFMTA's voice radio channels, and to determine the proper number of voice and data radio channels necessary to support all transit operations through year 2017 (10 year growth).

The following table represents which channels were used to compile fixed route voice traffic volumes.

TABLE 1 – RADIO CHANNELS

Radio Channel Number/Name	Base Tx (MHz)	Base Rx (MHz)	Notes
Radio CH 1A-Light Rail /Voice #1	484.66250	487.66250	Above & Below Ground
Radio CH 2B-Trolly/Voice #2	484.51250	487.51250	Above Ground Only
Radio CH 3D-Trolly/Voice #3	484.61250	487.61250	Above Ground Only
Radio CH 4E-Coach/Voice #4	484.71250	487.71250	Above Ground Only
Radio CH 5G-Coach/Voice # 5	482.88750	485.88750	Above Ground & Light Rail Voice Backup (Below Ground)
Radio CH Security #1/Voice #6	483.03750	486.03750	Above Ground Only
Radio CH Security #2/Voice #7	483.13750	486.13750	Above Ground Only
Radio CH Portables/Voice #8	485.47500	488.47500	Miscellaneous Communications
Radio CH Security Planned/Voice #9	488.56250	491.56250	Newly Activated Channel
Radio CH Cable Machinery/Voice #10	855.23750	810.23750	Above Ground Only
Radio CH Muni Security (old)/Voice #11	30.74000	30.74000	Unit-To-Unit Communications
Radio CH Ops& Maintenance/Voice #12	31.14000	31.14000	Unit-To-Unit Communications
DPT-A1-PCO Dispatch/Voice #13	806/821	869/824	Above & Below Ground
DPT-A2-Admin& Eng/Voice #14	806/821	869/824	Above & Below Ground
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	806/821	869/824	Above & Below Ground
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	806/821	869/824	Above & Below Ground
DPT-A5-Special Events/Voice #17	806/821	869/824	Above & Below Ground
DPT-A6-Traffic Cntrl. Ctr/Voice #18	806/821	869/824	Above & Below Ground
DPT-PD-11-Muni Tac & Co. K/Voice #19[1]	806/821	869/824	Above & Below Ground
DPT-Scofflaw/Voice #20	806/821	869/824	Above & Below Ground
DPT-Tow Dispatch/Voice #21	806/821	869/824	Above & Below Ground
The Following Data Channels Were Not Utilized For Voice Traffic Analysis			
Radio CH 6C-Light Rail/Data #1	484.56250	487.56250	Above & Below Ground
Radio CH 7F-Coach/Data #2	484.76250	487.76250	Above Ground Only

Radio Channels 1-21 (voice channels) were considered as part of the overall traffic analysis for this

[1] Channel "DPT-PD - A11" is programmed into DPT radios. It is used to communicate with City police as needed. It contained very limited traffic.

Report. Data Channels 1 and 2 will be appraised separately under in *Section 3.2.5 - Present Transit Data Channels.*

3.1 Traffic Analysis

SFMTA traffic was analyzed by separating the voice traffic data associated which each radio channel/talkgroup. The voice channels listed in Table 1 will be compiled for analysis to determine the following;

- Overall Voice Traffic (on 21 radio channels)
- Traffic By Time of Day (establishes the overall Busy Hour)
- Traffic By Channel (establishes the Busiest Hour By Channel)

The existing system utilizes a total of twenty-one (21) radio channels/talkgroups for voice and two (2) radio channels for transit type data. The voice traffic represents communications between radio users and dispatchers. The majority of the traffic between radio users (direct unit-to-unit traffic) was not fully captured for analysis since it is not recorded and difficult to monitor off-air. In addition, the following radio channels contained no traffic.

- Radio CH Muni Security (old)/Voice #11
- DPT-PD-11-Muni Tac & Co. K/Voice #19

The transit data channels (Channels Data 1 & Data 2) support the wireless system control functions and features used by the radio network to control, manage and gather data from the transit CAD/AVL network. The transit data traffic will not be compiled as part of the voice traffic analysis, since these channels are dedicated to the purpose of processing Request to Talk (RTT), Priority Request to Talk (PRTT), Emergency Alarm (EA) and Vehicle Location data, and are essentially required to operate the transit network. In other words, the transit data channels have been optimized to support the current network features, number of buses, and the functional design requirements. Therefore, traffic analysis is not required.

However, future data application support shall be considered in order to determine future capacity requirements. See *Section 3.2.5, Present Transit Data Channels*.

3.1.1 Data Source

Voice traffic data was obtained through the following methods:

- ✓ Macro Corporation's Air Traffic Logger monitored 12 of SFMTA's voice radio channels (referred to as channels 1 thru 12) off-the-air from Oakland, CA (55 days);

- ✓ The San Francisco Department of Emergency Management (DEM) provided historic measured air traffic for the Department of Parking & Transportation's (DPT) trunked talkgroups. There were 16,166 records provided, covering approximately 92 days of radio voice traffic.

Analysis Method

Macro monitored 12-channels of off-the air voice radio transmissions from June 16, 2008 through August 5, 2008 (55 days).[2] This included voice traffic for all transit operations. These dates were selected by SFMTA as representative of their operation. These records became the basis of this analysis.

[2] Radio CH Cable Machinery/Voice #10 was monitored for a shorter period since BAH/Macro was not aware of its existence until later.

These records identify each radio channel's activity by using the following elements:

- Channel Name
- Date
- Hour Of The Day
- Airtime Duration (by total seconds per hours)
- Transmission count (by hour)

The DPT traffic data was taken between March 1, 2008 and May 31, 2008 (92 days). This data contained both airtime and number of push-to-talks (transmission count). It was derived from the trunked Citywide Emergency Radio System (CERS) trunked radio management system.

Appendix A, Peak Busy Hour Airtimes - By Channels & Hour of the Day provides the raw traffic data from the SFMTA and CERS radio systems.

3.2 Overview of Measured Voice Traffic

The following table summarizes the distribution of traffic among the various radio channels.

Ideally, data from different networks would be collected during the same time period and duration to insure the traffic profile is correlated to time. In this case, the "raw" traffic was collected over different periods and for different lengths of time. For consistency, Macro normalized this data to account for this.

The following two tables provide summary traffic totals by the various channels/talkgroups within SFMTA's wireless voice networks. *Table 2* provides the compiled totals by radio channels for monitoring periods of 55 (SFMTA's networks) days and 92 days (CERS network). *Table 2A* provides the compiled totals when the traffic data has been normalized for a 92 day period.

TABLE 2 -55/ 92-DAYS AIRTIME TOTALS BY CHANNEL

Channel Name	55/92-Day Airtime Sum (seconds)	Percentage of Total (%)
Radio CH 1A-Light Rail /Voice #1	538,972	8.02%
Radio CH 2B-Trolly/Voice #2	449,924	6.70%
Radio CH 3D-Trolly/Voice #3	494,149	7.35%
Radio CH 4E-Coach/Voice #4	473,336	7.05%
Radio CH 5G-Coach/Voice # 5	292,243	4.35%
Radio CH Security #1/Voice #6	16,200	0.24%
Radio CH Security #2/Voice #7	1,480	0.02%
Radio CH Portables/Voice #8	83	0.00%
Radio CH Security Planned/Voice #9	113	0.00%
Radio CH Cable Machinery/Voice #10	30,808	0.46%
Radio CH Muni Security (old)/Voice #11	0	0.00%
Radio CH Ops& Maintenance/Voice #12	12	0.00%
DPT-A1-PCO Dispatch/Voice #13	1,791,210	26.66%
DPT-A2-Admin& Eng/Voice #14	40,154	0.60%
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	85,672	1.28%
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	12,584	0.19%
DPT-A5-Special Events/Voice #17	409,813	6.10%
DPT-A6-Traffic Cntrl. Ctr/Voice #18	420,527	6.26%
DPT-PD-11-Muni Tac & Co. K/Voice #19	0	0.00%
DPT-Scofflaw/Voice #20	1,010,415	15.04%
DPT-Tow Dispatch/Voice #21	650,852	9.69%
Subtotals	**6,718,547**	**100.00%**
Time Duration Correction Factor (55 days vs. 92 days)	1,545,470	
Totals (Corrected)	**8,264,017**	**100.00%**

TABLE 2A - 92-DAYS AIRTIME TOTALS BY CHANNEL - NORMALIZED		
Channel Name	**92-Day Airtime Sum (seconds)**	**Percentage of Total (%)**
Radio CH 1A-Light Rail /Voice #1	901,553	10.91%
Radio CH 2B-Trolly/Voice #2	752,600	9.11%
Radio CH 3D-Trolly/Voice #3	826,577	10.00%
Radio CH 4E-Coach/Voice #4	791,762	9.58%
Radio CH 5G-Coach/Voice # 5	488,843	5.92%
Radio CH Security #1/Voice #6	27,099	0.33%
Radio CH Security #2/Voice #7	2,475	0.03%
Radio CH Portables/Voice #8	139	0.00%
Radio CH Security Planned/Voice #9	190	0.00%
Radio CH Cable Machinery/Voice #10	51,534	0.62%
Radio CH Muni Security (old)/Voice #11	0	0.00%
Radio CH Ops& Maintenance/Voice #12	20	0.00%
DPT-A1-PCO Dispatch/Voice #13	1,791,210	21.67%
DPT-A2-Admin& Eng/Voice #14	40,154	0.49%
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	85,672	1.04%
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	12,584	0.15%
DPT-A5-Special Events/Voice #17	409,813	4.96%
DPT-A6-Traffic Cntrl. Ctr/Voice #18	420,527	5.09%
DPT-PD-11-Muni Tac & Co. K/Voice #19	0	0.00%
DPT-Scofflaw/Voice #20	1,010,415	12.23%
DPT-Tow Dispatch/Voice #21	650,852	7.88%
Totals	**8,264,017**	**100.00%**

A correction factor of to normalize the difference between 92 days of data vs. 55 days of data taken from the two different sources is approximately 67.3%. The additional traffic data (37 additional days of traffic on the SFMTA networks) was added to the 55 days of SFMTA's traffic data as an apportionment of the total traffic. This is reflected above in Table 2A.

Table 2B provides the airtime totals and the associated networks supporting the radio users as part of the total traffic being generated by SFMTA.

TABLE 2B - AIRTIME PERCENTAGE TOTALS BY NETWORKS		
Netwotk/Department Type/Channel Name	**92-Day Airtime Sum (seconds)**	**Percentage of Total (%)**
SFMTA's Transit Trunked - Revenue Vehicles		***45.51%***
Radio CH 1A-Light Rail /Voice #1	901,553	10.91%
Radio CH 2B-Trolly/Voice #2	752,600	9.11%
Radio CH 3D-Trolly/Voice #3	826,577	10.00%
Radio CH 4E-Coach/Voice #4	791,762	9.58%
Radio CH 5G-Coach/Voice # 5	488,843	5.92%
SFMTA's Conventional - Operations		***0.99%***
Radio CH Security #1/Voice #6	27,099	0.33%
Radio CH Security #2/Voice #7	2,475	0.03%
Radio CH Portables/Voice #8	139	0.00%
Radio CH Security Planned/Voice #9	190	0.00%
Radio CH Cable Machinery/Voice #10	51,534	0.62%
CERS Centtralized Trunked - DPT		***53.50%***
Radio CH Muni Security (old)/Voice #11	0	0.00%
Radio CH Ops& Maintenance/Voice #12	20	0.00%
DPT-A1-PCO Dispatch/Voice #13	1,791,210	21.67%
DPT-A2-Admin& Eng/Voice #14	40,154	0.49%
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	85,672	1.04%
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	12,584	0.15%
DPT-A5-Special Events/Voice #17	409,813	4.96%
DPT-A6-Traffic Cntrl. Ctr/Voice #18	420,527	5.09%
DPT-PD-11-Muni Tac & Co. K/Voice #19	0	0.00%
DPT-Scofflaw/Voice #20	1,010,415	12.23%
DPT-Tow Dispatch/Voice #21	650,852	7.88%
Totals	**8,264,017**	**100.00%**

Overall voice traffic is expected to be unevenly distributed, due to the nature of the various operations supported on the different radio channels and the type of system access utilized to support voice traffic. SFMTA's voice traffic is supported by the following access methods;

- **Open Channel**
  - Muni Security, Cable Machinery, Ops/Maintenance, Portables (Conventional)
  - DPT (Centralized Trunked; CERS)
- **Closed Channel**
  - Light Rail, Trolley, Coaches (Transit Trunked, Metrocom/CAD/AVL)

There are many instances where a mix of light and heavy traffic does occur during an hour. This phenomenon is important to understand since there are a limited number of radio channels (resources) to support the traffic during hourly periods of heavy traffic. In other words, the long measurement time period (92 days) effectively hides specific busy and non-busy periods and is too broad a measurement to indicate the current grade of service. However, it does indicate that overall use of the dispatcher-controlled channels is generally even, except for the 5G-Coach/Voice # 5, which is lower than the others. It also confirms SFMTA's earlier findings that these channels have longer wait times than others. In addition, channel DPT-A1-PCO Dispatch/Voice #13, which is part of the CERS system, is extremely busy.

This is not a surprise that the traffic loading is evenly distributed on the Coach, Trolley and Light Rail channels since the vehicles are pre-assigned to a dispatcher and/or radio channel. Also, transit dispatchers can manage the release of an RF channel, effectively metering requests to talk from the operators. If the wait times are not excessive, then the ratio of requests to talk and the number of transit coordinators is appropriate for the overall operations to function efficiently. If the wait times are excessive, then the ratio of requests to talk and the number of transit coordinators is not appropriate for the overall operations to function efficiently.

The following radio channels individually represent from 0.33% to 21.68% of the traffic, or *54.49% respectively of the total traffic.* The Department of Parking & Transportation, administration, security, supervisor and maintenance & repair operations use these radio channels. If the dispatch operation on DPT –AI-PCO/Voice CH13 is omitted from the totals (21.68%) the traffic decreases to 32.81% of the Total traffic.

- Radio CH Security #1/Voice #6
- Radio CH Security #2/Voice #7
- Radio CH Portables/Voice #8
- Radio CH Security Planned/Voice #9
- Radio CH Cable Machinery/Voice #10
- Radio CH Ops& Maintenance/Voice #12
- DPT-A1-PCO Dispatch/Voice #13
- DPT-A2-Admin& Eng/Voice #14
- DPT-A3-Paint & Traffic Sig. Shops/Voice #15
- DPT-A4-Meter Repair 7 Sign Shops/Voice #16
- DPT-A5-Special Events/Voice #17
- DPT-A6-Traffic Cntrl. Ctr/Voice #18
- DPT-Scofflaw/Voice #20
- DPT-Tow Dispatch/Voice #21

The following radio channels individually represent from 5.91% to 10.91% of the traffic and *45.51% respectively of the total traffic.* These radio channels/talkgroups are used by the portions of the DPT operations, Light Rail, Trolley and Coach operations and typically produce most of the traffic.

- Radio CH 1A-Light Rail /Voice #1
- Radio CH 2B-Trolly/Voice #2
- Radio CH 3D-Trolly/Voice #3
- Radio CH 4E-Coach/Voice #4
- Radio CH 5G-Coach/Voice # 5

The following channels have very limited traffic, could not be monitored or have been abandoned. They represent *.63% of the total traffic* and render a typical amount of traffic for transit systems.

- Radio CH Portables/Voice #8
- Radio CH Security Planned/Voice #9
- Radio CH Cable Machinery/Voice #10
- Radio CH Muni Security (old)/Voice #11
- Radio CH Ops& Maintenance/Voice #12

The DPT-Scofflaw/Voice #20 channel represents *12.23% of the total traffic* for one operation.

3.2.1 Traffic by Time of Day (Hour)

In order to take a more representative snapshot of all the radio channels predicated upon the available traffic data, the busiest traffic months were chosen. The goal is to determine the "peak busy" hourly traffic rate across entire radio networks. Table 3 was compiled from the voice traffic data acquired from the months of May (CERS wireless network) and July (SFMTA wireless networks). The daily hours (0 thru 23) were summed for each radio channel over a 31-day period to identify the busiest hour.

AIRTIME TOTALS BY MONTHS (Raw Traffic Data)			
Network/Department	**Month (2008)**	**Airtime (seconds)**	**Notes**
CERS/DPT	March	1,415,456	Full Month of Traffic
CERS/DPT	April	1,485,952	Full Month of Traffic
CERS/DPT	May	***1,520,265***	Full Month of Traffic
SFMTA	June	698,392	15 Days of Traffic
SFMTA	July	***1,382,825***	Full Month of Traffic
SFMTA	August	216,103	5 Days of Traffic

Table 3 below is a summary of the hourly traffic over two different 31-day periods. The CERS traffic for May 2008 and the SFMTA's traffic for the month of July 2008 are represented in this table.

Table 3 indicates that the busiest portions of a day occur between 0900 and 1800 hours, with 1000 and 1200 (1000 to 1100 & 1200 to 1300) being the heaviest 2 hours.

The "busiest hour" is Hour 10 (1000 to 1100) in which 209,927 second of traffic was produced over the entire set of radio channels being operated by SFMTA. These hours are a total of all hourly traffic[3].

[3] Table 3 is the total traffic by hour for all 19 channels/talkgroups

TABLE 3 - 31- DAY COMPOSITE TOTALS BY HOUR			
Hour of the Day (24-hour)	**Composite Airtime Sum (seconds)**	**Hour of the Day (24-hour)**	**Composite Airtime Sum (seconds)**
0 Total	11,700	***12 Total***	***209,187***
1 Total	24,542	13 Total	193,365
2 Total	19,044	14 Total	171,657
3 Total	18,282	15 Total	186,877
4 Total	20,872	16 Total	182,760
5 Total	49,412	17 Total	162,896
6 Total	91,116	18 Total	141,208
7 Total	158,863	19 Total	117,521
8 Total	164,877	20 Total	101,455
9 Total	193,167	21 Total	83,467
10 Total	***209,927***	22 Total	86,355
11 Total	217,677	23 Total	66,219
31-Day - Total			**2,882,447**

Current Voice Channels

These 19 (non-zero-airtime) channels are transit-trunked, centralized-trunked or conventional access based, depending on upon the transit system design. The revenue fleet is transit-trunked and the transit dispatchers' have the ability to process requests to talk (channel requests) from the vehicle operators. The DPT talkgroups are centralized-trunked the other operations are on conventional access methods. The elements, which make up the communications profile and affect the traffic, are as follows;

- Number of vehicles (active)
- Number of transit dispatchers (during each shift)
- Number of requests to talk
- Wait times to gain access to a dispatcher
- Duration of calls

The "transit-trunked" process manages all the voice traffic on Radio Channels 1, 2, 3, 4 and 5. Channel wait times have not been satisfactory since complaints have been indicated.

The "centralized-trunked" CERS system manages all of the voice traffic on talkgroups A1, A2, A3, A4, A5, A6, Scofflaw and Tow Dispatch. Channel wait times have been satisfactory since no complaints have been indicated.

The remaining channels are accessible on a conventional basis; traffic here is very low (.063% of the total traffic)

The usual method to analyze such traffic is to sum the airtime contribution from all 19 channels during each hour, over the 31-day period (e.g., the sum of the airtimes from all nineteen channels, derived between the hours of 5 PM and 6 PM [Hour 17] on a given day). This would result in 744 "hour totals" (31 days X 24 hours = 744). The hour with the greatest amount of airtime could be chosen as representative hour as the basis for design (before future growth was considered).

Since the airtime contribution from each channel is derived from the same hourly period, lightly used channels will effectively offset busier ones, allowing a new radio system to be designed with fewer traffic channels.

However, since the measurement period was only 31 days (although there were no reports of significant service disruptions or other events), it suggests that this load should be considered as a

minimum baseline.

To establish a more conservative baseline, which may be more representative of SFMTA's busy periods, the *peak* one-hour airtime load for each channel was identified and added to the peak one-hour airtimes of the other channels to form a "sum of peaks." This resulting load value would *simulate* the condition where each of the 19 channels is experiencing a busy period, all during the same one-hour period.

Table 4 below shows the results of this approach. We have provided the date and time of the particular channel peak, and a relative "% Hour" column that indicates what portion of an hour the particular channel is occupied.

TABLE 4 - BUSIEST HOUR TRAFFIC BY CHANNEL

Channel Name	Date	Day	Period	Airtime (sec.)	% of Hour	% of Traffic
Radio CH 1A-Light Rail /Voice #1	6/20/2008	Fri.	2-3 PM	1,511	42.0%	6.4%
Radio CH 2B-Trolly/Voice #2	6/24/2008	Tues.	4-5 PM	1,598	44.4%	6.8%
Radio CH 3D-Trolly/Voice #3	6/20/2008	Fri.	2-3 PM	1,697	47.1%	7.2%
Radio CH 4E-Coach/Voice #4	6/20/2008	Fri.	1-2 PM	1,626	45.2%	6.9%
Radio CH 5G-Coach/Voice # 5	7/3/2008	Thurs.	9-10 AM	947	26.3%	4.0%
Radio CH Security #1/Voice #6	7/19/2008	Sat.	3-4 PM	179	5.0%	0.8%
Radio CH Security #2/Voice #7	7/24/2008	Thurs.	11-12 AM	170	4.7%	0.7%
Radio CH Portables/Voice #8	7/12/2008	Sat.	8-9 AM	10	0.3%	0.0%
Radio CH Security Planned/Voice #9	7/31/2008	Thurs.	10-11 AM	5	0.1%	0.0%
Radio CH Cable Machinery/Voice #10	7/2/2008	Wed.	1-2 AM	643	17.9%	2.7%
Radio CH Muni Security (old)/Voice #11	***No Traffic***					
Radio CH Ops& Maintenance/Voice #12	7/1/2008	Tues.	1-2 PM	2	0.1%	0.0%
DPT-A1-PCO Dispatch/Voice #13	5/3/2008	Sat.	11-12 AM	2,704	75.1%	11.5%
DPT-A2-Admin& Eng/Voice #14	5/6/2008	Tues.	8-9AM	1,606	44.6%	6.8%
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	3/11/2008	Tues.	11-12 AM	973	27.0%	4.1%
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	4/22/2008	Tues.	3-4 PM	457	12.7%	1.9%
DPT-A5-Special Events/Voice #17	4/7/2008	Mon.	3-4 PM	1,883	52.3%	8.0%
DPT-A6-Traffic Cntrl. Ctr/Voice #18	4/9/2008	Wed.	2-3 PM	2,457	68.3%	10.5%
DPT-PD-11-Muni Tac & Co. K/Voice #19	***No Traffic***					
DPT-Scofflaw/Voice #20	5/23/2008	Fri.	11-12 PM	1,768	49.1%	7.5%
DPT-Tow Dispatch/Voice #21	4/22/2008	Tues.	10-11 AM	3,210	89.2%	13.7%
Peak Busy Hour Airtime (seconds)				**23,447**		
Dispatch & Revenue Vehicle Voice Traffic				31.5%		
Operations Voice Traffic				68.5%		

The sum of the peak airtimes was calculated to be 23,447 seconds[4]. This is the established "Peak Busy Hour Airtime" Hour (PBHA) value for analysis throughout the remaining sections of this Report. The 23,447 seconds equates to having seven channels continuously busy for one hour.[5]

3.2.2 Analysis of Current Traffic Load

The distribution and division of radio voice traffic and the volume of associated traffic will be reviewed in the following sections. Keep in mind that Radio Channels 1, 2, 3, 4 and 5 are accessed based upon the transit coordinators' release of a channel (transit trunked) and Radio Channels 13, 14, 15, 16, 17, 18, 20, and 21 are public safety trunked the access of the remainder of the radio channels is based upon contention (push to talk). These three types of access need to be viewed differently with respect to traffic loading analysis and prediction of the need for additional channels as the number of

[4] Based upon May 2008 and July 2008, 31 days of traffic data

[5] Since each radio "channel" has 3600 seconds (1 hour) of available airtime, 23,447/3600 = 6.5, or seven channels.

users or transit coordinators changes (increases or decreases in the future). Let's start by reviewing traffic activity and distribution by channels.

3.2.2.1 Assessment of Transit-Trunked Voice Channels

Utilizing the 92-day airtime totals from *Table 2A*, Radio Channels 1, 2, 3 and 4 carry similar amounts of traffic to each other and Radio Channel 5 carries the least percentage of traffic.

Then, referring to *Table 4*, all but one of the primary radio channels had experienced excessive loads during at least one hour of the 55 days (a conventional channel or trunked talkgroup is considered excessively loaded when it is busy over 33% of the time during an hour; the 33% [1,180 seconds] *utilization threshold* is where message collisions on contention-based channels start rising, requirement re-transmission, resulting in overload conditions. Of the one primary channel that was more lightly loaded, it exceeds 20%, which is still considered moderately busy.

Table 5 below describes how often each channel exceeded the 33% threshold over the 31 days. The voice channels do not vary much since they are controlled by the CAD system; here, the key factor is queue length (wait time). However, it is clear that Channels 1, 2, 3 and 4 do not regularly exceed 33% loading.

TABLE 5 – CHANNELS EXCEEDING 33% LOADING

Channel Name	No. Hours Load Exceeded 33%	Percent of Time (1320 Hrs.)
Radio CH 1A-Light Rail /Voice #1	8	0.60%
Radio CH 2B-Trolly/Voice #2	9	0.68%
Radio CH 3D-Trolly/Voice #3	18	1.36%
Radio CH 4E-Coach/Voice #4	10	0.76%

Currently, the maximum number of simultaneous revenue fleet voice conversations is five (5), assuming there are five transit coordinators available. If a sixth request to talk is received, the request is placed in a waiting queue. As long as the wait time is not excessive then the process for managing the request is acceptable and the number of radio channels is sufficient.

Based upon the compiled and extracted traffic data, SFMTA's revenue vehicle operation occasionally reaches capacity limits.

Conclusion

- Under busiest hour traffic conditions, SFMTA's Fleet Voice infrastructure is not often at maximum capacity.

3.2.2.2 Assessment of Centralized-Trunked Voice Channels

DPT Radio users on the CERS system operate on eight different talkgroups represented below:

- DPT-A1-PCO Dispatch/Voice #13
- DPT-A2-Admin& Eng/Voice #14
- DPT-A3-Paint & Traffic Sig. Shops/Voice #15
- DPT-A4-Meter Repair 7 Sign Shops/Voice #16
- DPT-A5-Special Events/Voice #17
- DPT-A6-Traffic Cntrl. Ctr/Voice #18
- DPT-Scofflaw/Voice #20
- DPT-Tow Dispatch/Voice #21

These radio users operate on a public safety type trunked system in which the individual user manages talkgroup access, but the assignment of an actual channel resource to carry a message is managed by a network radio switch (trunking controller).

From the perspective of talkgroup usage, DPT-A1-PCO Dispatch/Voice #13 routinely exceeds the 33% load point, with DPT-Tow Dispatch/Voice #21 having similar characteristics. However, this could be reduced by splitting these users over additional talkgroups since these are trunked. However, some channel may require dispatch support, requiring additional staff or automation to accomplish this.

From the perspective of the CERS trunked radio network, and its channel resources, DPT did not report any significant wait times to obtain channels access. Thus, there are likely enough radio trunks available in the CERS network to handle DPT's (and other CERS users') current load. Unlike conventional radio systems, where 33% channel utilization is considered maximum, Public-safety type trunking systems can utilize a voice channel up to 100% since it is managed by a central control system that maintains a view of activity on all channels simultaneously, assigning users needing to communicate to a clear and dedicated channel.

3.2.3 Present Transit Operations Voice Channels (Conventional)

These channels are contention-based and provide access on a first-come, first-served basis. These six (6) channels are supporting 0.99% of the total average traffic (Table 2A). The elements that make up the communications process and affect the service are as follows:

- Number of radio users
- Number of calls
- Duration of calls (voice traffic)

This contention process is utilized for all the voice traffic on Radio Channels 6, 7, 8, 9, 10 and 12. The present number of radio users requiring access to a channel when needed has been satisfactory for since limited complaints have been indicated.

3.2.3.1 Assessment of Transit Operations Voice Channels

Based upon the compiled traffic data, all transit operations channels are not experiencing overloading or excessive wait times since the percentage of traffic loading is greatly below the 33% threshold.

Conclusion

- Under the busiest hour traffic conditions SFMTA Transit operations is supported well by six (6) RF conventional channels.

3.2.4 Assessment of Existing Revenue Fleet and Operations Voice Requirements

Based on the combined SFMTA and DPT airtime of 23,447 seconds (equivalent to 6.51 Erlangs[6]), and no less than a 2% Grade of Service (GOS)[7] during busy hour, the revenue fleet and associated operations would require thirteen (13) "talk paths" using a centralized trunked-type system. The actual number of radio frequencies needed would depend on the radio technology employed.[8] For typical centralized trunked systems, the number of frequencies would be N+1, or 14 frequencies. The

[6] One Erlang is 3,600 call seconds, or 1 hour. 23,447 seconds = 6.51 Erlangs.
[7] A 2% GOS indicates that no more than 2% of call attempts would experience a busy (or "no trunks available" signal), during the busiest hour. This is a typical value used for public safety and critical infrastructure transit systems.
[8] Current analog, or P25 Phase I (FDMA) systems, frequency pairs (or channels) = talk paths. Project 25 Phase II (TDMA) systems, frequency pairs (or channels) = talk paths/2. Some proprietary TDMA systems can provide four to six talk paths per frequency pair or channel.

additional trunk is for the system control channel.

3.2.5 Present Transit Data Channels

Transit data traffic is being operated on Data Radio Channels 1 and 2. The type of data being sent on these two channels is as follows:

- Vehicle ID/Sector
- Vehicle Polling Requests
- Vehicle Location Information (signposts)
- Request to Talk (RTT)
- Priority Request to Talk (PRTT)
- Emergency Alarms (EA)

Typical Metrocom data systems of the age used by SFMTA, can poll about six buses per second (or 360 buses per minute), per channel. At peak service periods, there are 1000 vehicles that transmit data over the two transit data channels. Therefore, the entire fleet can be polled in less than 83 seconds (1.4 minutes). The system also supports four contention message slots for RTT, PRTT and EA messages on each of the two channels.

The capacity of a transit data channel will depend upon the type of data being sent, associated message length, air-link protocol (including channel bandwidth), polling cycle and radio transmitter/receiver response times.[9] Currently, the industry attempts to maintain a fleet polling cycle time of two minutes (maximum) and a bus poll rate of 4-6 per second (for 2400 and 9600 bps[10] air rates). This is 240 to 360 buses per minute. Therefore, it is apparent that the poll rate of SFMTA's existing system currently meets that of most other commercially available systems today.

The two data channels have been designed and optimized to provide an acceptable service level. The transit data channels appear adequate for the current control of the existing network.

3.2.5.1 Assessment of Transit Data Channels

The current two data channels support the existing transit data sub-system based upon the following requirements:

- Each RF channel supports approximately one-half of the fleet (approximately 500 vehicles per channel during peak service periods)
- Polling requirement of vehicle location occurs approximately every 3 minutes
- 6 polls are sent every second, 360 vehicles per minute capacity
- Data channel date rate is likely 2400 bps @ 25kHz channel bandwidth

Conclusion

- Based upon discussion with SFMTA the current data channels are functioning properly to support the transit network.

The addition of on-board vehicle intelligent devices will be discussed in Section 4.2 of the Report.

[9] Modern radio equipment that has been optimized for data communications can reach close to full transmit power in under 20 ms.

[10] The term bps is Bits per Second.

SECTION 4. FUTURE SYSTEM CAPACITY REQUIREMENTS

This section determines the aggregate channel requirements for any large-scale shared radio system for fixed route and related operations traffic. Such an analysis is applicable to standard trunked simulcast radio systems, whether analog voice or digital voice.

If the future system architecture were to be based on a multi-site approach (not simulcast), where each tower site operates on different radio channels, more information would be needed describing the location of data users during the peak busy hour.[11]

4.1 Approach

To estimate the future capacity requirements, MACRO follows a simple three-step approach:

Step 1: *Determine (aggregate) peak busy hour airtime (PBHA)*

Step 2: *Establish a Load Basis; this is PBHA plus anticipated growth from current suppressed demand*

Step 3: *Apply compounded growth factors to Load Basis (i.e., 5 plus years)*

Step 4: *Calculate future system capacity*

Step 1: Determine Peak Busy Hour Airtime (PBHA)

The (aggregate) PBHA is used as a starting point in which to estimate future traffic loads. The PBHA was established earlier at 23,447 seconds.

It is not sufficient to assume that the PBHA will remain the same on a large-scale shared system with private-conventional channels or private trunked channels. In addition, this would also hold true for the leased public-trunked channels "talk-path" networks offering SFMTA the required capabilities to support future communications. It is quite common that overall airtimes will increase if groups of users currently on a shared channel were to migrate to their own independent private channel. This is referred to as "suppressed demand". Suppressed demand is estimated in the next step.

Step 2: Establish a Load Basis

The Load Basis is the sum of the PBHA (above) plus suppressed demand. Please refer to *Table 6 – Estimate Traffic Increase – Due To Suppressed Traffic*, which provides the details of the analysis.

The transit coordinators manage Radio Channels 1, 2, 3, 4 and 5. This process will reduce the chances of reaching the threshold contention factor of 33% (0.33 Erlangs). But if the transit dispatcher were not controlling radio channel access there would be suppressed traffic. In light of this, the PBHA traffic loads would increase.

Furthermore, Radio Channels 6, 7, 8, 9 and 10 are based on a contention scheme for gaining channel access, but their loading is sufficiently small as to not warrant a suppressed demand factor. The only exception is Channel 10 (Cable Machinery), but even this channel is well below the suppressed demand figure. Therefore the PBHA traffic loads would not be increased. Table 6 applies a suppressed demand factor, by channel.

[11] It is recommended that a separate geographic analysis be considered. Such information would further narrow down future channel requirements, and encourage additional competition during the vendor proposal stage of the project (a greater number of vendors are capable of providing a multi-site architecture compared with simulcast).

The suppressed demand would also be applied to traffic carried on the CERS centralized-type trunked radio network.

TABLE 6 - ESTIMATED TRAFFIC INCREASE - DUE TO SUPPRESSED DEMAND

Channel Name	Airtime (sec.)	Suppressed Demand Factor	Load Basis (sec.)
Radio CH 1A-Light Rail /Voice #1	1,511	9%	1,647
Radio CH 2B-Trolly/Voice #2	1,598	11%	1,780
Radio CH 3D-Trolly/Voice #3	1,697	14%	1,937
Radio CH 4E-Coach/Voice #4	1,626	12%	1,824
Radio CH 5G-Coach/Voice # 5	947		947
Radio CH Security #1/Voice #6	179		179
Radio CH Security #2/Voice #7	170		170
Radio CH Portables/Voice #8	10		10
Radio CH Security Planned/Voice #9	5		5
Radio CH Cable Machinery/Voice #10	643		643
Radio CH Muni Security (old)/Voice #11	0		0
Radio CH Ops& Maintenance/Voice #12	2		2
DPT-A1-PCO Dispatch/Voice #13	2,704	42%	3,843
DPT-A2-Admin& Eng/Voice #14	1,606	12%	1,792
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	973		973
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	457		457
DPT-A5-Special Events/Voice #17	1,883	19%	2,247
DPT-A6-Traffic Cntrl. Ctr/Voice #18	2,457	35%	3,323
DPT-PD-11-Muni Tac & Co. K/Voice #19	0		0
DPT-Scofflaw/Voice #20	1,768	16%	2,053
DPT-Tow Dispatch/Voice #21	3,210	56%	5,013
	23,447		
Total Including Suppressed Traffic			**28,845**

The following definitions apply to each column heading:

Suppressed Demand Factor – A rough estimate of the immediate growth in traffic if these particular users were partitioned into, or given a private talk-path, if one were available. It is the amount of traffic that would have been present had the current channel been available (or not busy) with other traffic, related or otherwise.

Load Basis - Provides the anticipated channel loads and total aggregate load basis, once users move to a new radio system.

Step 3: Apply compounded growth factors to Load Basis

In determining future radio traffic growth, population trends must be considered, as well as expected improvements in SFMTA's service levels (the possible growth in radio-equipped personnel) and greater use of radio due to decreasing equipment costs. Therefore, the following summarizes the factors that will affect growth and the number of RF channels required to support any associated traffic increases.

- Population (increased ridership, additional vehicles)
- SFMTA's Service Area (additional vehicles)

- Additional Personnel (increase of wireless devices)
- On-board Vehicle Intelligence (increase of data from wireless devices)

As access to the network is increased for voice and data applications the increase in traffic and the associated RF capacity of the network needs to be considered in order to maintain the same or better grade of service to the users and SFMTA transit's operations. Historically, as use of data applications grows (messaging, status, location, polling, etc.), radio channel efficiency has improved (properly developed software and data devices can transport more information in less time than previously utilized voice methods). Therefore, when planning for growth the driving elements and the associated methods in which solutions are developed must be considered as part of any growth calculations for RF channel capacity and traffic increase.

Looking at the previously mentioned factors that will ultimately produce growth, determination of the expected increase in wireless devices and associated voice and data traffic is of major importance to determine the RF channels required to support these changes. In order to construct the growth analysis, modeling of the influencing drivers, potential solutions and expected impacts are presented below, based upon experience with transit system advancements of this type.

Increased Ridership	**Increased Service Area**	**Additional Personnel**	**On-Board Vehicle Intelligence**	**Additional Transit Operations**
Requires More Buses	Requires More Buses	Requires more Wireless Devices	Requires More Wireless Devices	Requires More Transit Vehicles
Requires More Channel Access	Requires More Channel Access	Requires More Channel Access	Requires More Channel Access	Requires More Channel Access
Direct Traffic Increase	Direct Traffic Increase	Direct Traffic Increase	Proportional Traffic Increase	Direct Traffic Increase
Expect 1:1[12] Increase (voice)	Expect 1:1 Increase (voice)	Expect 1:1 Increase (voice)	Expect 1:0.4[13] Increase (data)	Expect 1:1 Increase (voice)

As indicated above, all but the On-Board Vehicle Intelligence devices *(or On-Board System, OBS)* would have a one-to-one impact on the traffic. In other words, for each additional radio added to the system there would be an associated incremental increase in hourly traffic. The OBS is different in that the final on-board integrated system solution will operate properly at faster data rates, and the data packets containing the information will increase slightly over the current packet lengths. Macro estimates the overall impact to be approximately 30% above the existing transit data subsystem.

Step 4: Calculate Future System Capacity

SFMTA Transit's Fleet Growth – Level 1 – Growth

In order to assess the impact of growth to the current traffic load, the best available data and driving factor was SFMTA's anticipated 10-year fleet growth plan. These increases in the vehicle fleet were used to establish future traffic loads. As mentioned previously, an increase in wireless devices will mean an increase in system access and traffic. The following fleet growth figures represent a total overall growth of 9.0% over the current quantities of radio users.

[12] This ratio (1:1 and such) refers to the expected proportional increase in traffic due to effect of the various growth elements
[13] This ratio (1:0.4) is less than a 1 to 1 effect since it is a data application creating less traffic as opposed to a voice application

TABLE 7 - ESTIMATED TRAFFIC INCREASE DUE TO GROWTH							
Year	**Quantity of Vehicle Radios (Revenue)**	**Quantity of Portable Radios (Non-Revenue)**	**Quantity of Portable Radios (SFMTA)**	**Quantity of Portable Radios (DPT)**	**Total Quanity of Radios**	**Total Increase (Radios)**	**% of Increase**
2008	1162	211	919	417	2,709	0	0
2009	1173	223	920	420	2,736	27	1.00%
2010	1184	235	921	423	2,763	27	1.00%
2011	1195	247	922	426	2,790	27	0.99%
2012	1206	259	923	429	2,817	27	0.98%
Totals (5yr)	**1206**	**259**	**923**	**429**	**2,817**	**108**	**3.99%**
2013	1217	271	924	432	2,844	27	1.00%
2014	1228	283	925	435	2,871	27	1.00%
2015	1239	295	926	438	2,898	27	1.00%
2016	1250	307	927	441	2,925	27	1.00%
2017	1261	319	928	444	2,952	27	1.00%
Totals (10yr)	**1261**	**319**	**928**	**444**	**2,952**	**135**	**4.98%**
Grand Total					***2,952***	***243***	***8.97%***

The growth was divided into 5-year sub-totals in order to calculate the impact to the current traffic loading figures. In addition, the apportionment of the anticipated increase in traffic was applied to each channel based on current individual channel traffic versus the total traffic. *Table 7 – Estimated Traffic Increase – Due To Growth* is provided in detail as well as an overall summary of the anticipated future traffic load due to growth.

Summary of Traffic Growth

Current Traffic Load, Seconds PBHA 2008	**28,845**
5 Year Traffic Load, Seconds PBHA (4.0%) 2012	**29,995**
10 Year Traffic Load, Seconds PBHA (5.0%) 2017	**31,433**

The estimated traffic increase due to growth needs to be apportioned to the final calculations to order to estimate the incremental growth by users. *Table 8* provides the estimates and associated incremental traffic apportionment base upon the user's percentage of the total traffic. This technique allows us to view the growth across the entire network at the radio user level.

TABLE -8 - ESTIMATED TRAFFIC INCREASE - DUE TO GROWTH						
Channel Name	**Load Basis (Table 6)**		**Load With Growth (Seconds)**		**Load With Growth (Erlang)**	
	(Seconds)	**(Erlangs)**	**5-Years (Seconds) 9.53%**	**10-Years (Seconds) 10.58%**	**5-Years (Erlangs)**	**10-Years (Erlangs)**
Radio CH 1A-Light Rail /Voice #1	1,647	0.457	1,698	1,763	0.472	0.490
Radio CH 2B-Trolly/Voice #2	1,780	0.494	1,836	1,906	0.510	0.529
Radio CH 3D-Trolly/Voice #3	1,937	0.538	1,998	2,074	0.555	0.576
Radio CH 4E-Coach/Voice #4	1,824	0.507	1,881	1,953	0.523	0.542
Radio CH 5G-Coach/Voice # 5	947	0.263	976	1,013	0.271	0.282
Radio CH Security #1/Voice #6	179	0.050	185	192	0.051	0.053
Radio CH Security #2/Voice #7	170	0.047	175	182	0.049	0.051
Radio CH Portables/Voice #8	10	0.003	11	11	0.003	0.003
Radio CH Security Planned/Voice #9	5	0.001	5	5	0.001	0.002
Radio CH Cable Machinery/Voice #10	643	0.179	664	689	0.184	0.191
Radio CH Muni Security (old)/Voice #11	0	0.000	0	0	0.000	0.000
Radio CH Ops & Maintenance/Voice #12	2	0.001	3	3	0.001	0.001
Apportioned Growth	*9,145*	*2.540*	*9,431*	*9,790*	*2.620*	*2.719*
DPT-A1-PCO Dispatch/Voice #13	3,843	1.067	3,996	4,034	1.110	1.121
DPT-A2-Admin& Eng/Voice #14	1,792	0.498	1,864	1,882	0.518	0.523
DPT-A3-Paint & Traffic Sig. Shops/Voice #15	973	0.270	1,012	1,022	0.281	0.284
DPT-A4-Meter Repair 7 Sign Shops/Voice #16	457	0.127	475	480	0.132	0.133
DPT-A5-Special Events/Voice #17	2,247	0.624	2,336	2,359	0.649	0.655
DPT-A6-Traffic Cntrl. Ctr/Voice #18	3,323	0.923	3,456	3,489	0.960	0.969
DPT-PD-11-Muni Tac & Co. K/Voice #19	0	0.000	0	0	0.000	0.000
DPT-Scofflaw/Voice #20	2,053	0.570	2,135	2,155	0.593	0.599
DPT-Tow Dispatch/Voice #21	5,013	1.392	5,213	5,263	1.448	1.462
Apportioned Growth	*19,701*	*5.472*	*20,487*	*20,684*	*5.691*	*5.745*
Hourly Totals	**28,845**	**8.013**	**29,918**	**30,474**	**8.311**	**8.465**

4.2 Data Traffic Analysis - Evaluation of Required Data Channels To Support OBS Applications

The evaluation of required data channels to support On Board Systems (OBS) data applications is based upon an estimated model, which was generated for this Report[14]. The following table summarizes the typical devices that will most likely be generating data and transported via a dedicated RF "transit data" channel (Labeled, Transit Data).

AIR TRANSPORT METHOD			
On Board Systems/Devices	**Current**	**Future**	**Transport Method**
Schedule		X	WLAN (Local)
Schedule Adherence		X	WiFi/WiMax
Signpost & Odometer AVL	X		Air Link
Automatic Passenger Counter (APC)		X	WLAN (Local)
Fare Box	X	X	WLAN (Local)
Smart Fare Transition		X	WLAN (Local)
Destination Sign	X	X	Transit Data
Security Camera	X	X	WLAN (Local)
Automatic Vehicle Tag	X	X	None
AVL/GPS System	X	X	Transit Data
Automatic Vehicle Monitoring		X	Transit Data
Transit Signal Priority	X	X	Air Link
Stop Announcement System		X	Transit Data
Data Messaging (canned)	X	X	Transit Data
Data Messaging (customed)		X	Transit Data

[14] Data Applications were not part of the scope of work on this project. Therefore the information is more generic than specific to SFMTA's onboard vehicles systems, but is considered useful information for analyzing the data traffic needs.

SFMTA utilizes two (2) current transit data channels (25 kHz channel bandwidth) that have available room to handle the current OBS applications. Using two (2) RF data channels, the current vehicle fleet is polled every 83 seconds.

Based upon an OBS design where small messages are being sent and received from the buses (see above listing for Air Transport Method) an expected increase in traffic of approximately 40% is a sound design assumption.

Other elements, which will also provide better future utilization of the data channel and reduce the amount of data traffic as well as increase the overall throughput, are listed below.

- Faster data rates (Currently 2400 bps, new system designed for 4800 bps and 9800 bps)[15]
- More efficient data packets and RF protocol
- Less voice communications due to data applications

One element, which would affect the amount of data being processed within required system time line, would be the reduction in channel bandwidths. Typically, reduced channel bandwidth has decreased the bits per second rates (data rate) as indicated below, which equates to the need for additional RF channels. Typically, if the channel bandwidth is reduced by 50% (1/2), then the data rate can also reduced by 50%. Therefore, the number of RF channels is increased by a factor of 2 (doubled).

Channel Bandwidths (kHz)	Data Rates (bps)	Notes
25	19,200	Current technology, maximum rates on private systems (requires more radio sites to maintain same RF coverage as data rates increase and channel bandwidths decrease)
12.5	9,600	
6.25	4,800	

4.3 Data Channel Considerations

The present allocation of two data channels has proved to be sufficient under the present operation, reportedly providing data communications with each revenue vehicle about every 83 seconds during peak hours (500 vehicles/channel or 1000 total vehicles). According to documentation provided by Motorola, the system was designed to poll approximately six (6) buses per second (approximately 180 milliseconds per poll[16]) on each channel. SFMTA advises that the over-the-air bit rate is 2400 bps.

4.3.1 Polling Rates

SFMTA has considered requiring a sub-one-minute update (poll), while suppliers are suggesting they could support 400 to 600 vehicles per data channel[17] (depending on supplier). This could mean that acquiring a new system will require one additional data channels (total of three), to support current operations. With respect to future growth (up to 50%) an additional data channel should be considered (total of four).

[15] Note that actual message throughput does not increase in proportion to raw air data rate; i.e., a doubling the raw rate will only result in an incremental increase in data throughput due to extra error correction overhead and other factors.
[16] This does not include contention slots or other available slots for messaging. Typically vendors reserve 20% for contention and messaging. Therefore, the polling rate would be approximately 144 milli-seconds (approximately 7/sec.) or 416 vehicles polled per minute on one RF channel.
[17] Based upon an over-the-air data rate of 2400 bps

4.3.2 Design Considerations

When designing the new SFMTA radio system, thought should be given to maximizing the efficiency of the data communications. This will depend to a large extent on the design of the on-board systems and the volume of data to be exchanged over a wireless LAN at the start or end of the day. Efficiency will also depend on the communications access control method and over the air protocol. Five points that warrant consideration include:

(a) The location of schedule adherence calculations – Most systems perform these calculations on the vehicle, in an effort to reduce data communications and provide the adherence data to other subsystems on the vehicle, like traffic signal priority. Adherence data will then be readily available to the operator, and can be sent to the communications coordinator for alarm only when it exceeds a threshold amount. This does require, however, that schedule data (time points) be provided to the vehicle.

(b) Route adherence calculations – As with schedule adherence, these calculations are usually also performed on the vehicle. In addition to the data being available to the operator, it will also be available to other vehicle subsystems, like automatic passenger announcements (inhibiting announcements when the vehicle is off-route). Route adherence data can be sent to the communications coordinator for alarm only when it exceeds a threshold amount. This does require, however, that route data (shape points) be provided to the vehicle.

(c) Data messages – Consideration should be given to the addition of data messages and the extent of their use, as this could increase data traffic. Specifically, pre-programmed or "canned" messages can significantly reduce message lengths as only a "message identifier" need be transmitted versus an entire text string.

(d) Vehicle status reporting – While some systems have suggested exception reporting of vehicle positions from the vehicles as a method to reduce data communications, this concept has led to the requirement of algorithms in the fixed-site systems to estimate vehicle locations on the communications coordinator's map. Even though vehicle positions would be updated with real time information when an actual location was received, vehicle positions were subject to errors and could move in reverse when the vehicle was not moving as fast as predicted. More common today is regular polling of vehicles, with the receipt of location data with each poll. Vehicle locations on the map tend to be more accurate under this concept. There are numerous other methods that contain elements of both these concepts that have been developed by the system suppliers, each with their own advantage and disadvantage.

(e) Access control and protocol – The traditional access control method used for fixed-route fleet service is time-division (TD) based, where bus message transmission is "prompted" by a central fixed polling system. Bus message transmission only occurs (and is only expected) within a pre-determined time window. This contrasts with other methods, such as contention-based "packet" models where message initiation originates in the vehicle (based on user or other threshold requirements). To ensure proper message routing, packet-based systems imbed additional information in each message to support the required routing information, lengthening each message considerably. In addition, certain communication protocols inherently require more system capacity than others (i.e., TCP/IP protocols rely on message acknowledgement to ensure delivery, versus UDP and others that are more "fire-and-forget" approaches with minimal header sizes).

(f) The use of UDP/IP as part of the system design will require additional consideration since message header sizes increase, or must be compressed. The compression of the IP routing information and the number of transit data channels needs to be investigated further. Section 4.4.1 of the Report provides insight to the design considerations.

Conclusion

- One to two additional Data Channels (12 kHz or 25 kHz, for a total, of 4) will be required as part of planning the for the CAD/AVL network to insure availability of RF channels to support a 50% growth in data traffic based upon a one minute polling cycle
- If channel bandwidth decreases no more RF channels will be required since the estimates are based on the lowest date rate of 2400 bps
- If UDP/IP addressing is utilized additional data channels will be required, ranging from a total of 6 to 9 depending on the CAD/AVL vendor (see Table 10)

4.4 Channel Requirements

Considering the total increase of SFMTA's fleet operation the impact to the traffic is indicated below in *Table -9 – Total Growth Estimates – PBHA & Required Channels*.

To properly size a trunked radio system, the accepted industry approach is to define the amount of traffic that a system should be able to handle during the peak busy hour, with a reasonable limit on the amount of blockage and delay.

Blockage is defined as the percentage of messages during the peak busy hour that will experience a "busy" condition on the first attempt.[18] Delay is the length of time that the blocked caller will experience the busy condition. These values are averages. While there is no industry standard established, 2% blockage is often used as a relatively stringent design criterion, such as for transit radio systems. The resulting delay will be dependent on the average length of call, i.e., "holding time", and the number of radio channels resources or trunks available. In our experience, the typical delay is under 1.5 seconds, based on average holding times of 5 seconds.[19]

Table 9 provides the required channel requirement for a shared radio system. It is based on industry accepted statistical formulas[20] and a 2% blockage criterion during the busy hour. It also adjusts the trunk resources to account for systems requiring an additional control or signaling channel (referred to as centralized-type trunking systems). The most common systems available today are centralized.

TABLE -9 - TOTAL GROWTH ESTIMATES - PBHA & REQUIRED CHANNELS

Year	SFMTA Traffic (CH 1 Thru 12)	DPT Traffic (CH 13 Thru 21)	Total Traffic	Erlangs	Voice Talk Paths	Voice Control Channel	Transit Data Channel	Trunks
SFMTA & DPT TRAFFIC								
2008	9,145	19,701	28,845	8.01	15	1	3	19
2012	9,431	20,487	29,918	8.31	16	1	4	21
2017	9,790	20,684	30,474	8.46	16	1	4	21
SFMTA TRAFFIC								
2008	9,145	0	9,145	2.54	7	1	3	11
2012	9,431	0	9,431	2.62	7	1	4	12
2017	9,790	0	9,790	2.72	8	1	4	13
DEPARTMENT OF PARKING & TRANSPORTATION (DPT)								
2008	0	19,701	19,701	5.47	12	1	0	13
2012	0	20,487	20,487	5.69	12	1	0	13
2017	0	20,684	20,684	5.75	12	1	0	13

Note: Any considerations for the quantity of RF channels required should be based on the year 2017 to ensure

[18] The user experiencing a busy is not required to press his/her transmit button again. Most public-safety radio systems will automatically alert the user when the busy condition clears.
[19] SFMTA's may be more or less.
[20] The Erlang C formula.

proper system sizing to meet expected growth.

As an example, if SFMTA is considering constructing s new network to support SFMTA traffic only (not DPT), BAH/Macro recommend that thirteen (13) radio frequency pairs, or channels, be available. This consists of nine (9) channels to support the voice radio system (eight voice plus one voice control channel), and four channels to support data operations. This assumes that an FDMA voice radio system is procured.

If (two-slot) TDMA technology were purchased (i.e., Project 25 Phase II), only four voice radio channels would be needed as TDMA provides two talks paths per voice radio channel. This would require total of nine (9) radio channels (four voice, one voice control channel, and four data channels).

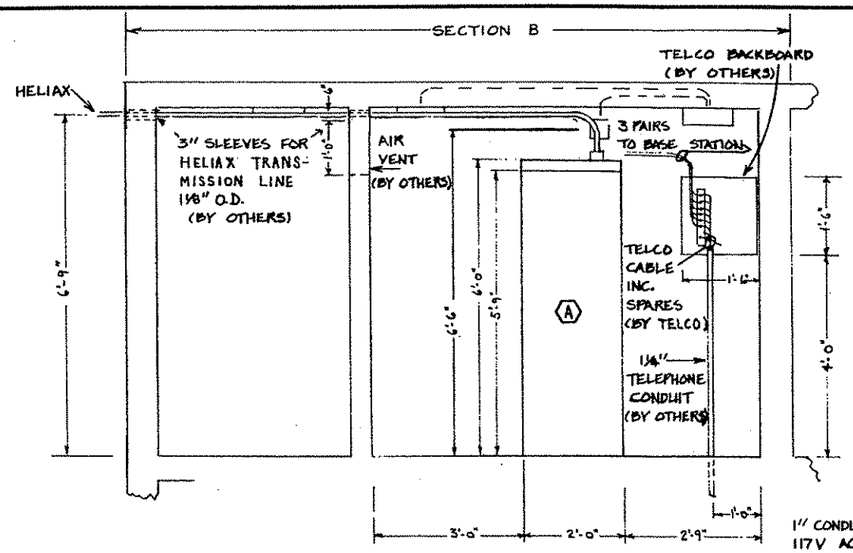
APPENDIX A

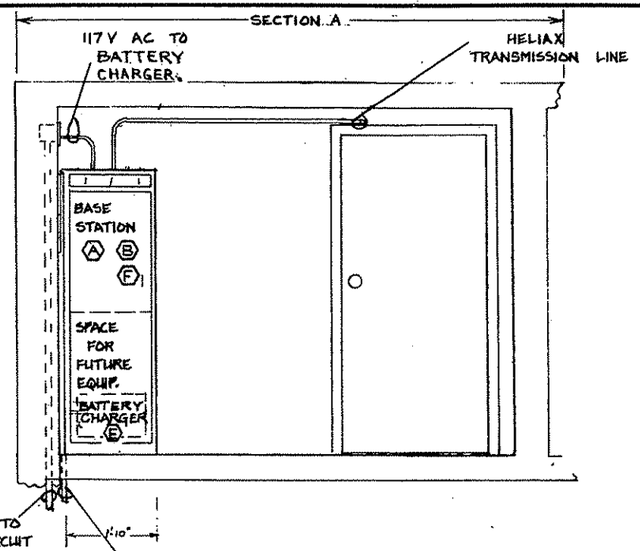
PEAK BUSY HOUR AIRTIMES - BY CHANNELS & HOUR OF THE DAY

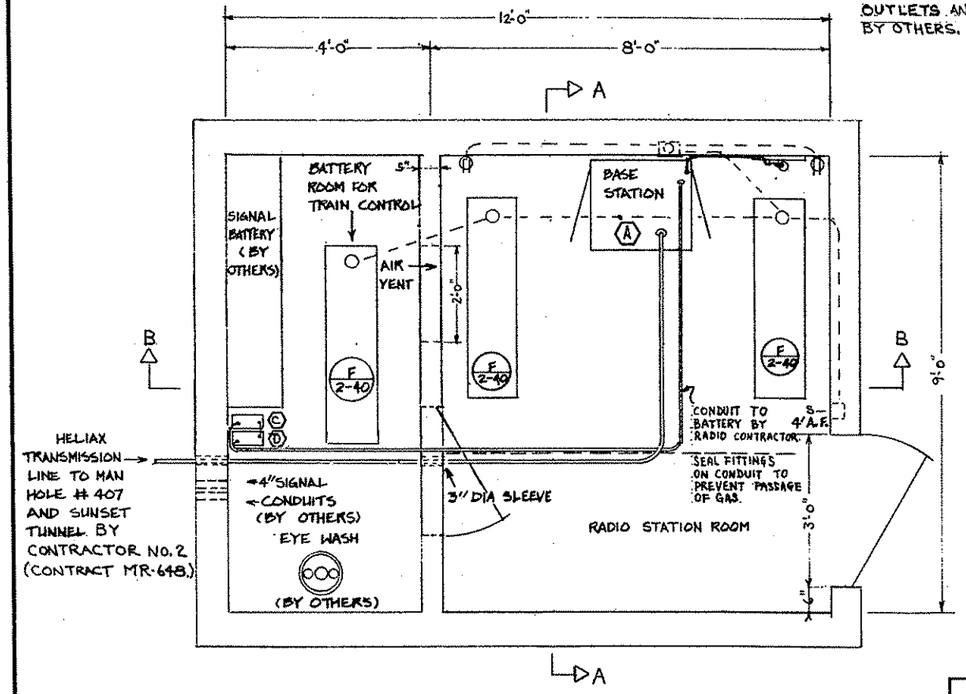
appendix **twenty**

Existing Underground Communications Drawings

for reference only




SECTION A
117 V AC TO BATTERY CHARGER
HELIAX TRANSMISSION LINE
BASE STATION
A B F
SPACE FOR FUTURE EQUIP.
BATTERY CHARGER E
1" CONDUIT TO 117 V AC CIRCUIT BREAKER PANEL AND WIRING FOR OUTLETS AND LIGHTS BY OTHERS.
1¼" CONDUIT TO TELCO BACKBOARD FOR BASE STATION CONTROL CIRCUITS (BY OTHERS)
1'-10"



PLAN VIEW

NOTES:
1. SEE CL-5863-2 FOR EQUIPMENT DESCRIPTIONS.
2. MINIMUM BEND RADIUS FOR HELIAX CABLE OUTSIDE OF CONDUIT IS 10".
3. MINIMUM BEND RADIUS OF CONDUIT FOR HELIAX CABLE IS 4'-0".
4. LOCATE THE 3" DIA. SLEEVE THROUGH WALL FOR HELIAX CABLE TO OBTAIN MOST DIRECT RUN.
5. LIGHTING FIXTURES AND LIGHTING WIRING AND CONDUITS TO BE BY OTHERS.

REGISTERED PROFESSIONAL ENGINEER R. A. ISBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

COMSUL LTD.
417 MONTGOMERY ST.
SAN FRANCISCO, CA 94104

NO.	DATE	DESCRIPTION	BY	APPR'D.
1	5/11/77	CONFORMED WITH M.R.629-R	R.A.I.	

REVISIONS

CONTRACT NO. M.R. 629-R

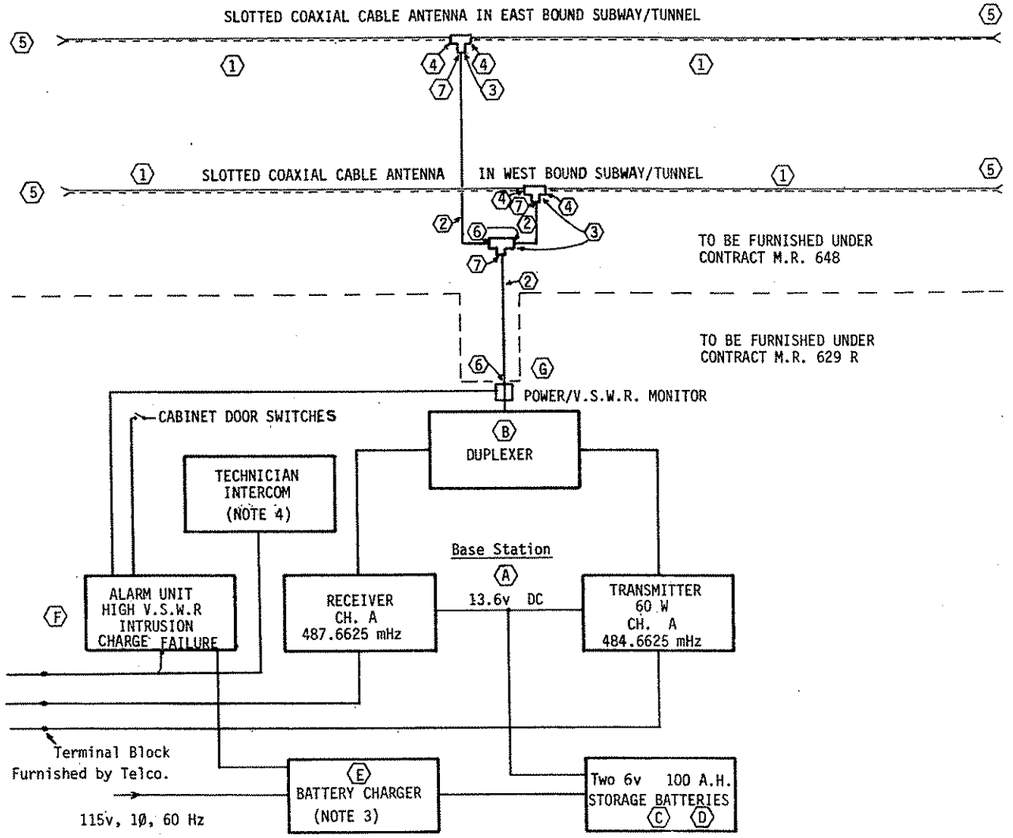
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM
ANTENNAS & BASE STATION NO. 7
CARL SUBSTATION

RECOMMENDED S. Yakahi	BY R.A. ISBERG	TR.	SCALE ½"=1'-0
APPROVED	DR. T.O.	CH. R.A. ISBERG	DATE 9-24-75
APPROVED George M. Duarte Deputy GENERAL MANAGER		DRAWING NO. BL-3497	REVISION NO. 1

SHEET 1 OF 1 SHEETS

PRINTED ON DIEPO NO. 1000M CLEARPRINT 11-74


SLOTTED COAXIAL CABLE ANTENNA IN EAST BOUND SUBWAY/TUNNEL
SLOTTED COAXIAL CABLE ANTENNA IN WEST BOUND SUBWAY/TUNNEL
TO BE FURNISHED UNDER CONTRACT M.R. 648
TO BE FURNISHED UNDER CONTRACT M.R. 629 R
POWER/V.S.W.R. MONITOR
CABINET DOOR SWITCHES
DUPLEXER
TECHNICIAN INTERCOM (NOTE 4)
Base Station
ALARM UNIT HIGH V.S.W.R INTRUSION CHARGE FAILURE
RECEIVER CH. A 487.6625 mHz
13.6v DC
TRANSMITTER 60 W CH. A 484.6625 mHz
Terminal Block Furnished by Telco.
115v, 1Ø, 60 Hz
BATTERY CHARGER (NOTE 3)
Two 6v 100 A.H. STORAGE BATTERIES

N O T E S

1. FOR SCHEMATIC DETAILS OF CONNECTIONS TO ANTENNA SYSTEM, REFER TO:

DRAWING NUMBER	SUBWAY/TUNNEL BASE STATION
CL-5860-3	FOREST HILL STATION (No. 4)
CL-5861-2	EUREKA STATION (No. 5)
CL-5862-1	CHURCH STATION (No. 6)
CL-5863-2	CARL SUBSTATION (No. 7)
CL-5864-3	CIVIC CENTER STATION (No. 8)
CL-5865-2	MONTGOMERY STATION (No. 9)

2. UNDERGROUND ANTENNA SYSTEM IS TO BE FURNISHED BY CONTRACTOR NO. 2 UNDER CONTRACT M.R. 648
3. BATTERY CHARGER MAY BE LOCATED IN BASE STATION CABINET.
4. TECHNICIAN INTERCOM MAY BE INCORPORATED IN BASE STATION.

ITEM	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
(1)	RADIATING CABLE, ANDREW RADIAX RX5-1R	3.01
(2)	FEEDER CABLE, ANDREW 7/8" LDF5-50 HELIAX.	3.06
(3)	POWER DIVIDER, ANDREW 42152 50 OHM, 50%-50%	6.01
(4)	CONNECTOR, ANDREW 45 AW, 7/8" RADIAX CABLE TO TYPE N MALE	5.01
(5)	CONNECTOR, ANDREW 45 AN, 7/8" RADIAX CABLE TO TYPE N FEMALE	5.01
(6)	CONNECTOR, ANDREW L45W, 7/8" LDF5-50 TO TYPE N MALE	5.02
(7)	CONNECTOR, ANDREW L45N, 7/8" LDF5-50 TO TYPE N FEMALE	5.02

ITEM	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 629R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R SPEC. SECTION
(A)	RADIO BASE STATION, 60 WATTS OUTPUT	5.28 5.21.02
(B)	DUPLEXER	5.21.05
(C)	STORAGE BATTERIES, Two 6v 100 A.H.	5.09.05
(D)	BATTERY RACK AND TRAY	
(E)	13.6V, 40A Ratelco VF12403R BATTERY CHARGER, ~~13v, 20 A RATELCO VF1240S~~ WITH CHARGE FAILURE ALARM, ADJUSTABLE FLOAT AND EQUALIZE VOLTAGE 0-24 HOUR TIMER CONTROL FOR EQUALIZING, CURRENT LIMITER, VOLT METER AND AMMETER	(Addi. 1) 5.09.03
(F)	ALARM UNIT	5.18
(G)	POWER/V.S.W.R. MONITOR	5.17

REGISTERED PROFESSIONAL ENGINEER R. A. ISBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

NO.	DATE	DESCRIPTION	BY	APPR'D.
1	5/18/77	COMPLETELY REVISED	R.A.I.	SY 7/6/77

REVISIONS

CONTRACT NO. M.R. 629-R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

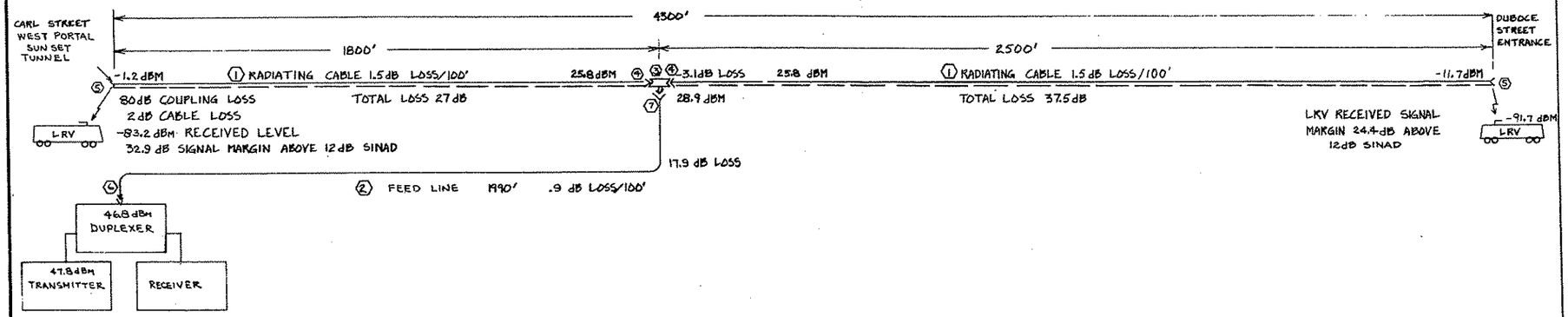
UHF RADIO SYSTEM FOR LRV
BLOCK DIAGRAM
BASE STATIONS IN SUBWAYS

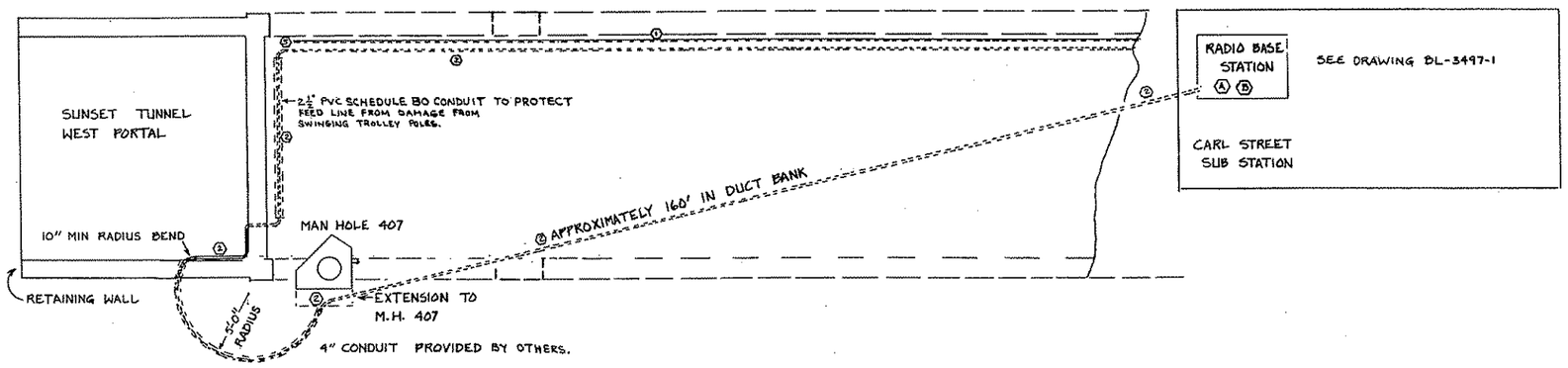
RECOMMENDED S. Yakaki	BY R.A. ISBERG	TR.	SCALE NONE
APPROVED [illegible]	DR. R.A.I.	CH. R.A.I.	DATE 5/18/77
APPROVED George M. Duncan Deputy GENERAL MANAGER	DRAWING NO. BL-3501		REVISION NO. 1

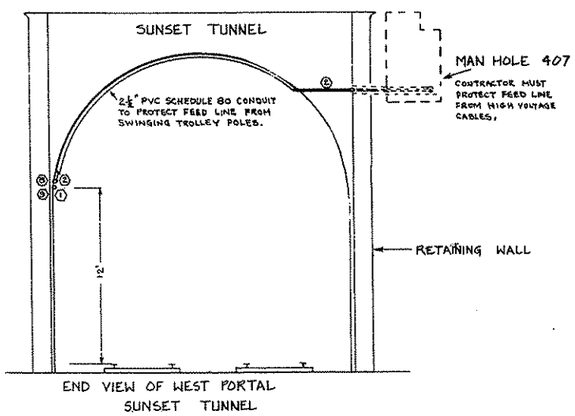
SHEET 1 OF 1 SHEETS

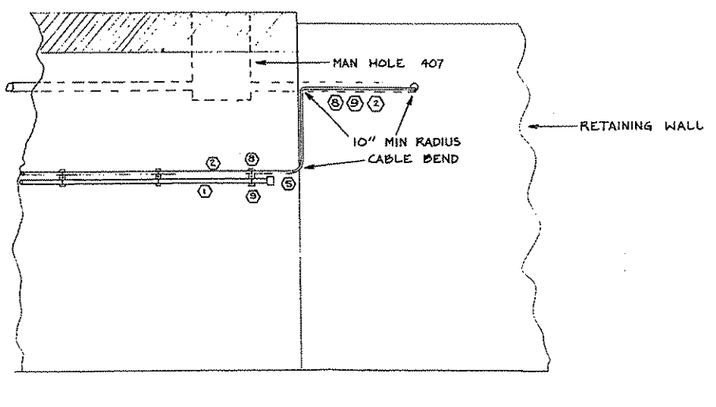
PRINTED ON DIEPO NO. 1000H CLEARPRINT 11-74

Schematic Diagram Of Radiating Cable System In Sunset Tunnel




SUNSET TUNNEL WEST PORTAL
2½" PVC SCHEDULE 80 CONDUIT TO PROTECT FEED LINE FROM DAMAGE FROM SWINGING TROLLEY POLES.
RADIO BASE STATION (A) (B)
SEE DRAWING BL-3497-1
CARL STREET SUB STATION
10" MIN RADIUS BEND
MAN HOLE 407
(3) APPROXIMATELY 160' IN DUCT BANK
RETAINING WALL
5'-0" RADIUS
EXTENSION TO M.H. 407
4" CONDUIT PROVIDED BY OTHERS.


SUNSET TUNNEL
MAN HOLE 407
CONTRACTOR MUST PROTECT FEED LINE FROM HIGH VOLTAGE CABLES.
2½" PVC SCHEDULE 80 CONDUIT TO PROTECT FEED LINE FROM SWINGING TROLLEY POLES.
RETAINING WALL
12'
END VIEW OF WEST PORTAL SUNSET TUNNEL



ITEM	QTY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
(1)	4300	RADIATING CABLE, ANDREW RADIAX RXS-1R	3.01
(2)	1990'	FEEDER CABLE, ANDREW 7/8" LDF5-50, HELIAX, FOAM DIELECTRIC	3.06
(3)	1	POWER DIVIDER, ANDREW 42152, 50 OHM, 50%-50%	6.01
(4)	2	CONNECTOR, ANDREW 45 AW, 7/8" RADIAX CABLE TO TYPE N MALE	5.01
(5)	2	CONNECTOR, ANDREW 45 AN, 7/8" RADIAX CABLE TO TYPE N FEMALE	5.02
(6)	1	CONNECTOR, ANDREW L45W, 7/8" LDF5-50 CABLE TO TYPE N MALE	5.02
(7)	1	CONNECTOR, ANDREW L45N, 7/8" LDF5-50 CABLE TO TYPE N FEMALE	5.02
(8)	788	ANCHOR FOR CONCRETE SURFACES, DIAMOND 01404	8.01
(9)	788	CABLE CLAMP FOR 7/8" CABLES ATTACHED TO CONCRETE ANCHOR, STAINLESS STEEL, ANDREW 40765-2	8.01

ITEM	QTY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 629R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R
(A)	1	RADIO BASE STATION, 60 WATTS OUTPUT	5.29 5.21.02
(B)	1	DUPLEXER	5.21.05
(C)	2	STORAGE BATTERIES, GLOBE TEL CELL 3GY13, 6 VOLT 100 A.H.	5.09.05
(D)	1	BATTERY RACK, TRAYS AND DRIP PAN	5.09.05
(E)	1	BATTERY CHARGER, RATELCO VF 12203R, 12v, 20A.	5.09.05
(F)	1	ALARM UNIT	5.18

CONTRACT NO. M.R. 648 & 629-R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM FOR LRV
ANTENNA & BASE STATION NO. 7
CARL SUB STATION

REGISTERED PROFESSIONAL ENGINEER R. A. ICBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

CONSUL LTD.
417 MONTGOMERY ST
SAN FRANCISCO CA 94104

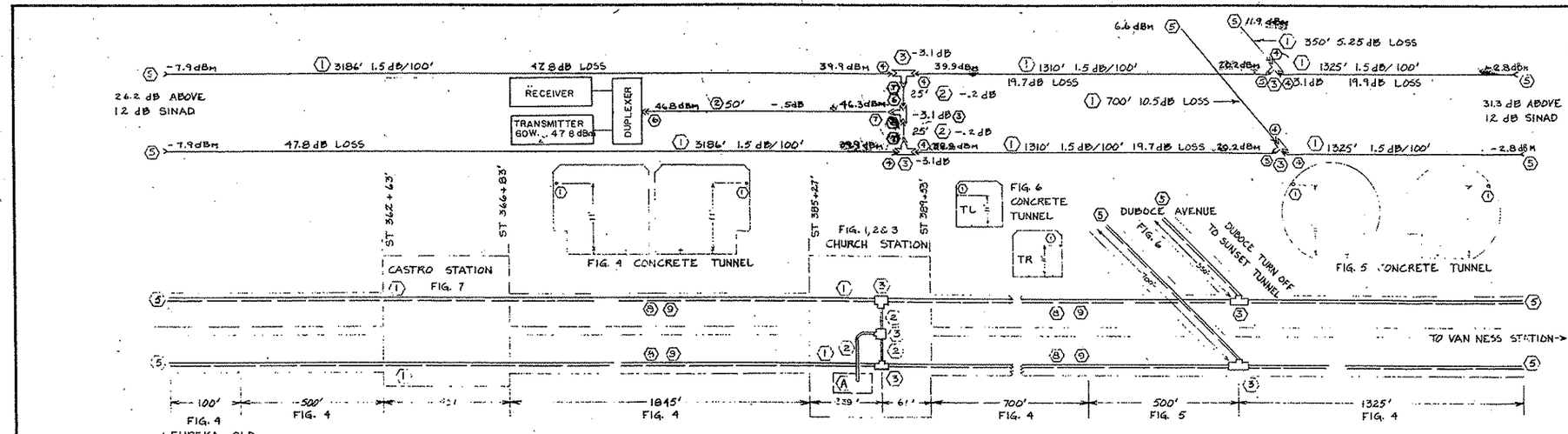
NO.	DATE	DESCRIPTION	BY	APPR'D.
2	5/12/77	CHANGED CONTRACT NO. & MATERIAL LIST	RAI.	
1	5/10/76	MOVED RF CABLES TO TRACE LEFT SIDE OF R.P. TO S.C.	R.A.I.	LH

REVISIONS

RECOMMENDED I. Yakahi Sr. Engr. TR.
APPROVED Louis Pelosi BY Klaus CH. R. A. ICBERG
APPROVED Lloyd M. Duarte Manager GENERAL MANAGER
SCALE N.S.
DATE 9-22-75
DRAWING NO. CL-5863
REVISION NO. 2

SHEET 1 OF 1 SHEETS

PRINTED ON DIEPO NO. 1000M CLEARPRINT 4-74



ITEM	Q'TY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 648 BY CONTRACTOR NO. 1	M.R. 648 SPEC.
1	12,692	RADIATING CABLE, ANDREW RADIAX FXS5-1R	16.01
2	100'	FEEDER CABLE, ANDREW FOAM DIELECTRIC LDF5-50	3.06
3	5	POWER DIVIDER, ANDREW 42152, 50%-50%,	6.01
4	8	CONNECTOR, ANDREW 45 AW 7/8" FOAM HELIAX TO TYPE N MALE	5.01
5	8	CONNECTOR, ANDREW 45 AN 7/8" FOAM HELIAX TO TYPE N FEMALE	5.01
6	3	CONNECTOR, ANDREW L45W FOR LDF5-50 CABLE TO N MALE	5.02
7	3	CONNECTOR, ANDREW L45N.	5.02
8	1587	ANCHOR FOR CONCRETE SURFACES, DIAMOND 01404	8.01
9	1587	CABLE CLAMP FOR 7/8" CABLES ATTACHED TO CONCRETE ANCHOR, STAINLESS STEEL, ANDREW 40785-2	8.01

ITEM	Q'TY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 629 R BY CONTRACTOR 1.	M.R. 629R SPEC.
A	1	RADIO BASE STATION, 60 WATTS OUTPUT	5.26 5.21.02
B	1	DUPLEXER	5.21.03
C	2	STORAGE BATTERIES, GLOBE TEL CELL 3 BY 13, 6 VOLT 100 A.H.	5.09.03
D	1	BATTERY RACK, TRAYS & DRIP PAN	5.09.05
E	1	BATTERY CHARGER	5.09.05
F	1	ALARM UNIT	5.18

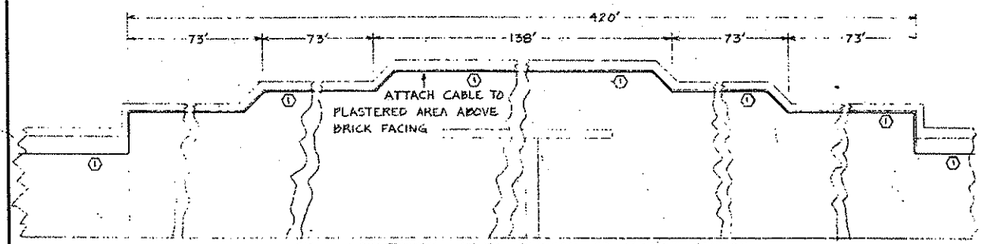
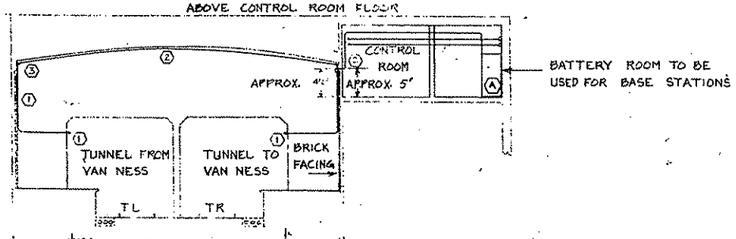


FIG. 3 LONGITUDINAL CROSS SECTION OF CHURCH STATION
WALLS ARE RED BRICK

TRANSMISSION LINE ② THROUGH 1½" DIA HOLE IN PLASTERED AREA ABOVE BRICK WALL FACING. LOCATION IS APPROXIMATELY 61' FROM TUNNEL ENTRANCE AND 4'-4" ABOVE CONTROL ROOM FLOOR



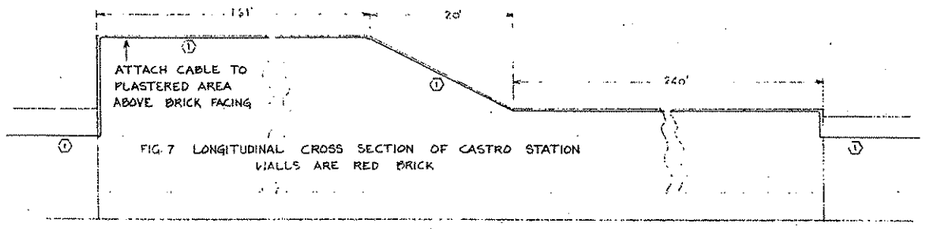
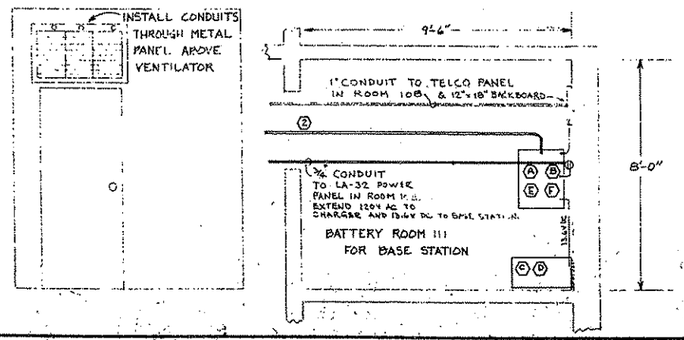
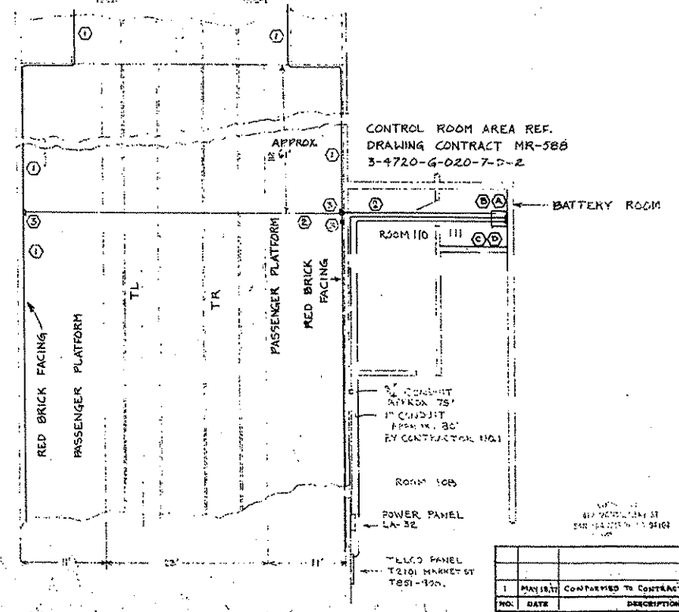


FIG. 7 LONGITUDINAL CROSS SECTION OF CASTRO STATION
WALLS ARE RED BRICK


INSTALL CONDUITS THROUGH METAL PANEL ABOVE VENTILATOR
9'-6"
1" CONDUIT TO TELCO PANEL IN ROOM 108 & 12"x18" BACKBOARD
¾" CONDUIT TO LA-32 POWER PANEL IN ROOM 108. EXTEND 120V AC TO CHARGER AND 130V DC TO BASE STATION.
BATTERY ROOM 111 FOR BASE STATION
8'-0"



CONTRACT NO. M.R. 648 & 629-R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

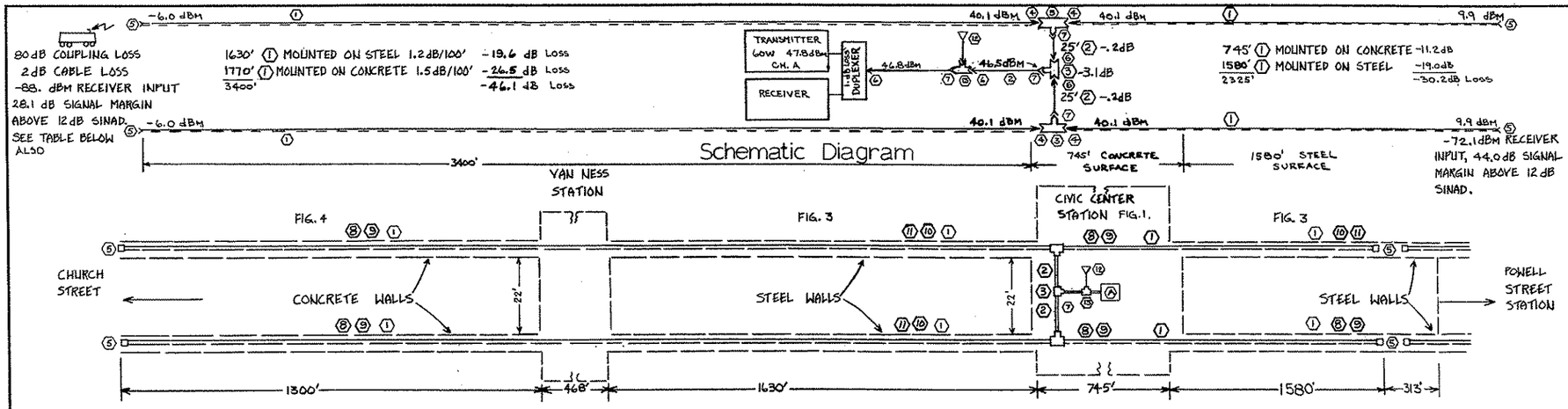
UHF RADIO SYSTEM FOR L.R.V.
ANTENNA & BASE STATION NO. 6
CHURCH STATION

NO.	DATE	DESCRIPTION	BY	APPRO.
1	MAY 18,'71	CONFORMED TO CONTRACTS MR-648-629R-RAL		

REVISIONS

RECOMMENDED S. Yakshi BY
APPROVED Thomas B. Owen BY
APPROVED Eugene E. Trefethen Jr. GENERAL MANAGER
SCALE: 1/8"=1'-0" DES. DRN. CHK. DATE: 1-27-70
DRAWING NO. CL 5962

SHEET OF



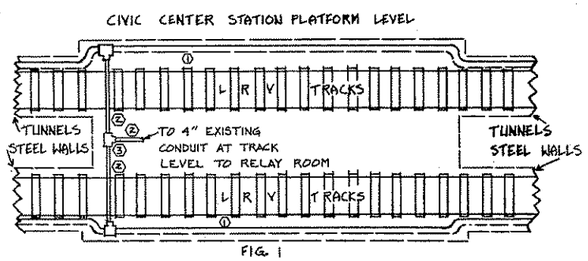

CIVIC CENTER STATION PLATFORM LEVEL
L R V TRACKS
TUNNELS STEEL WALLS
TO 4" EXISTING CONDUIT AT TRACK LEVEL TO RELAY ROOM
TUNNELS STEEL WALLS
L R V TRACKS

FIG. 1

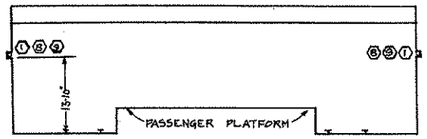
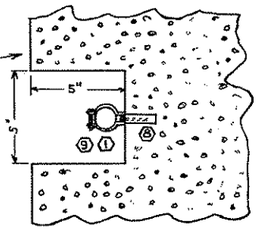


FIG. 1 SECTION THROUGH CIVIC CENTER STATION SHOWING MOUNTING FOR SLOTTED COAXIAL CABLE IN RECESSED AREAS IN DECORATIVE WALLS.



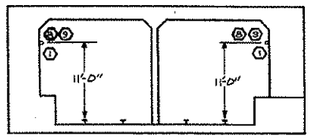


FIG. 4 TWIN CONCRETE RECTANGULAR VAN NESS TO DUBOCE

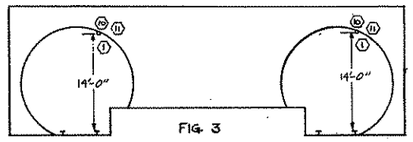
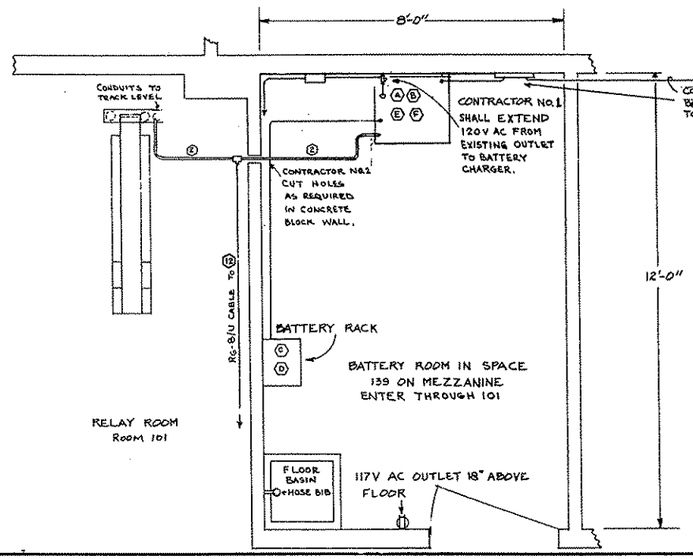


FIG. 3

TWIN STEEL TUBES, EMBARCADERO TO VAN NESS


8'-0"
CONDUITS TO TRENCH LEVEL
CONTRACTOR NO.1 SHALL EXTEND 120 V AC FROM EXISTING OUTLET TO BATTERY CHARGER.
CONTRACTOR NO.1 INSTALL 12"x18" BACK BOARD AND 75' 1" CONDUIT... TO TELCO PAY STATIONS NEAR 8TH & GROVE EXIT.
CONTRACTOR NO.2 CUT HOLES AS REQUIRED IN CONCRETE BLOCK WALL.
RG-8/U CABLE TO
12'-0"
BATTERY RACK
BATTERY ROOM IN SPACE 139 ON MEZZANINE ENTER THROUGH 101
RELAY ROOM Room 101
FLOOR BASIN W/HOSE BIB
117V AC OUTLET 18" ABOVE FLOOR

COMPUTATION OF SIGNAL STRENGTH RECEIVED AT BASE STATION FROM HAND HELD TRANSCEIVER NEAR WESTERN END OF RADIAX CABLE	
COUPLING LOSS BETWEEN TRANCEIVER 20' FROM RADIAX CABLE	-80 dB
ATTENUATION OF 3400' RADIAX CABLE	-46.1dB
ATTENUATION OF POWER DIVIDERS	- 7.2 dB
ATTENUATION OF .75' FOAM HELIAX FEEDER CABLE	- 0.7 dB
DUPLEXER LOSS	- 1.0 dB
TOTAL LOSSES	135 dB
EFFECTIVE RADIATED POWER FROM 3.5 WATT TRANSCEIVER	+35.4 dBm
INPUT SIGNAL TO BASE STATION RECEIVER	-99.6 dBm
SIGNAL MARGIN ABOVE 12 dB SINAD	16.5 dB

ITEM	QTY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
(1)	11,450	RADIATING CABLE, ANDREW RADIAX RX5-1R	3.01
(2)	100'	FEEDER CABLE, ANDREW 7/8" LDF5-50 HELIAX, FOAM DIELECTRIC	3.06
(3)	3	POWER DIVIDER, ANDREW 42152, 50 OHM, 50%-50%	6.01
(4)	4	CONNECTOR, ANDREW 45 AW, 7/8" RADIAX CABLE TO TYPE N MALE	5.01
(5)	4	CONNECTOR, ANDREW 45 AN, 7/8" RADIAX CABLE TO TYPE N FEMALE	5.01
(6)	4	CONNECTOR, ANDREW L45W, 7/8" LDF5-50 CABLE TO TYPE N MALE	5.02
(7)	4	CONNECTOR, ANDREW L45N, 7/8" LDF5-50 CABLE TO TYPE N FEMALE	5.02
(8)	640	ANCHOR FOR CONCRETE SURFACES, DIAMOND 01404	8.01
(9)	640	CABLE CLAMP FOR 7/8" CABLES ATTACHED TO CONCRETE ANCHOR, STAINLESS STEEL, ANDREW 40785-2	8.01
(10)	825	CLAMP FOR ATTACHING TO METAL I BEAMS, STAINLESS STEEL, ANDREW 31768A-2	8.02
(11)	825	CABLE CLAMP FOR 7/8" CABLES SPACED FROM STEEL SURFACES, MOLDED PLASTIC SPACER, ANDREW 36719	8.03
(12)	1	ANTENNA MOUNTED ON CEILING	7.01
(13)	1	POWER DIVIDER, 1%-99% TELEWAVE CUSTOM	6.02

ITEM	QTY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 629R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R SPEC. SECTION
(A)	1	RADIO BASE STATIONS 60 WATTS OUTPUT	5.25 5.21.02
(B)		DUPLEXER	5.21.05
(C)	2	STORAGE BATTERIES, GLOBE TEL CELL 3 GY 13 6 VOLT, 100 A.H.	5.09.05
(D)	1	BATTERY RACK	5.09.05
(E)	1	BATTERY CHARGER	5.09.05
(F)	1	ALARM UNIT	5.18

CONTRACT NO. M.R. 648 & 629-R

REGISTERED PROFESSIONAL ENGINEER R. A. ISBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

NO.	DATE	DESCRIPTION	BY	APP'D.
3	5/16/77	CONFORMED TO MR 648 & MR 629R	R.A.I.	
2	5-2-76	CHANGED CH. A TO CH. C DELETED ANTENNAS VAN NESS STATION	R.A.I.	B.H.
1	1/21/76	ADDED RADIATING ANTENNAS	R.A.I.	B.H.

REVISIONS

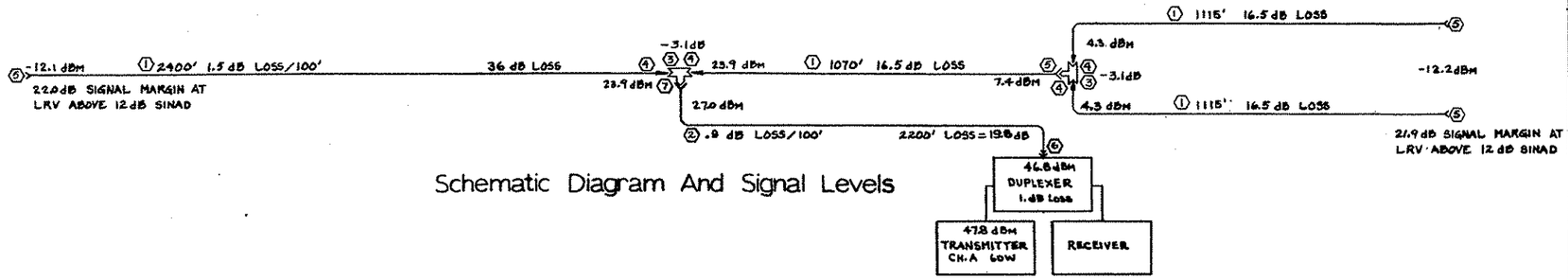
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM FOR LRV ANTENNA & BASE STATION NO. 8 CIVIC CENTER STATION

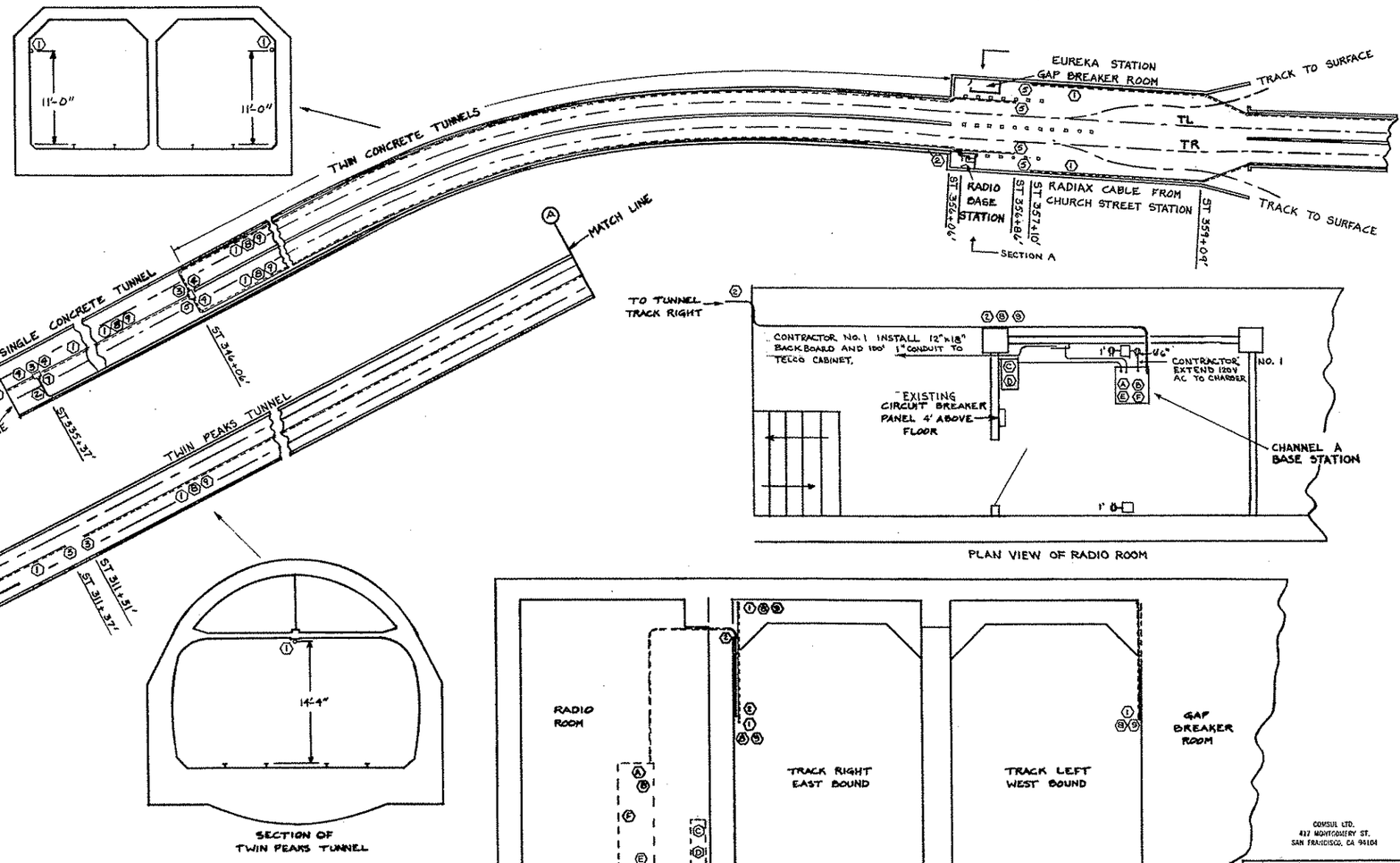
RECOMMENDED S. Yakabi	BY R.A.I.	TR.	SCALE N.S.
CH. R.A.I.	DD.	DATE 11-21-75	
APPROVED Geo. M. Duarte		DRAWING NO. CL-5864	REVISION NO. 3
GENERAL MANAGER			

SHEET 1 OF SHEETS

FAIRFIELD-ON DIEPO NO. 1000M CLEARPRINT 4-76



Schematic Diagram And Signal Levels



ITEM	QTY.	MATERIAL TO BE FURNISHED UNDER CONTRACT NO. M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
①	5700'	RADIATING CABLE, ANDREW RADIAX RX5-1R	3.01
②	2200'	FEEDER CABLE, ANDREW 7/8" LDF5-50 HELIAX, FOAM DILECTRIC	3.06
③	2	POWER DIVIDER, ANDREW 42152 50 OHM 50%-50%	6.01
④	4	CONNECTOR, ANDREW 45 AW 7/8" RADIAX CABLE TO TYPE N MALE	5.01
⑤	4	CONNECTOR, ANDREW 45 AN 7/8" RADIAX CABLE TO TYPE N FEMALE	5.01
⑥	1	CONNECTOR, ANDREW L45W 7/8" LDF5-50 TO TYPE N MALE	5.02
⑦	1	CONNECTOR, ANDREW L45N 7/8" LDF5-50 TO TYPE N FEMALE	5.02
⑧	988	ANCHOR FOR CONCRETE SURFACES DIAMOND 01404	8.01
⑨	988	CABLE CLAMP FOR 7/8" CABLE ATTACHED TO CONCRETE ANCHOR, STAINLESS STEEL, ANDREW 40785-2	8.01

ITEM	QTY.	MATERIAL TO BE FURNISHED UNDER CONTRACT M.R. 629-R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R SPEC. SECTION
(A)	1	RADIO BASE STATION 60 WATT OUTPUT	5.27 5.21.02
(B)	1	DUPLEXER	5.21.05
(C)	2	STORAGE BATTERIES, 6 VOLT 100 A.H. GLOBE TEL CELL 3 GY 13.	5.09.05
(D)	1	BATTERY RACK, TRAYS & DRIP PAN	5.05.05
(E)	1	BATTERY CHARGER RATELCO VF 12203R, 12v, 20A	5.09.05
(F)	1	ALARM UNIT	5.18

COMSUL LTD.
417 MONTGOMERY ST.
SAN FRANCISCO, CA 94104

REGISTERED PROFESSIONAL ENGINEER R. A. ISBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

NO.	DATE	DESCRIPTION	BY	APP'D.
2	5/2/77	CHANGED CONTRACT NO. & DELETED CH. C	R.a.S.	
1	2/5/76	CHANGED SHEET NO. ADDED SECTIONS A & B	R.a.S.	R.a.S.

REVISIONS

CONTRACT NO. M.R. 648 & 629-R

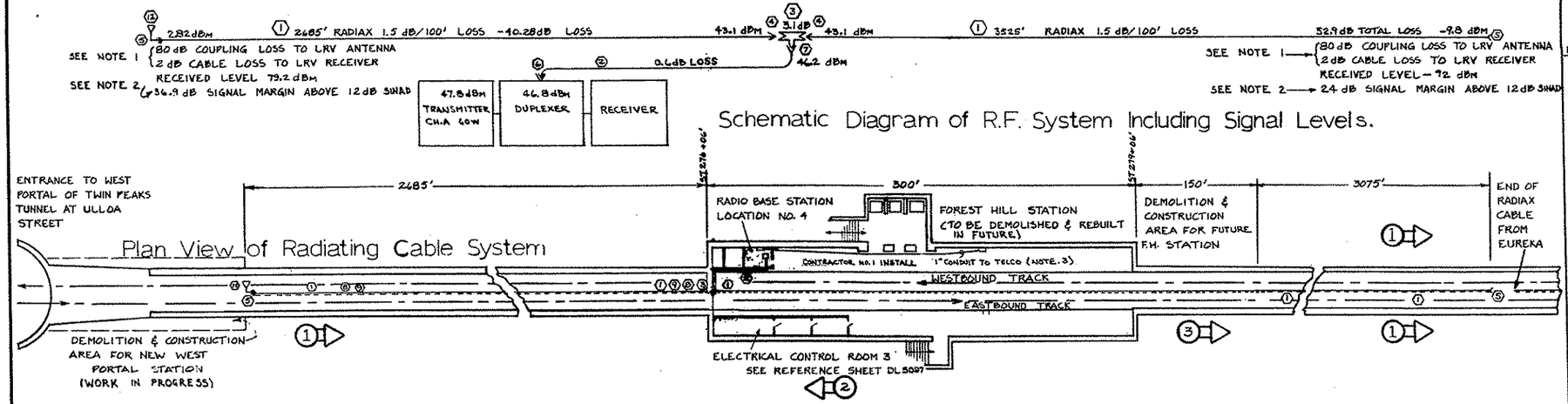
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

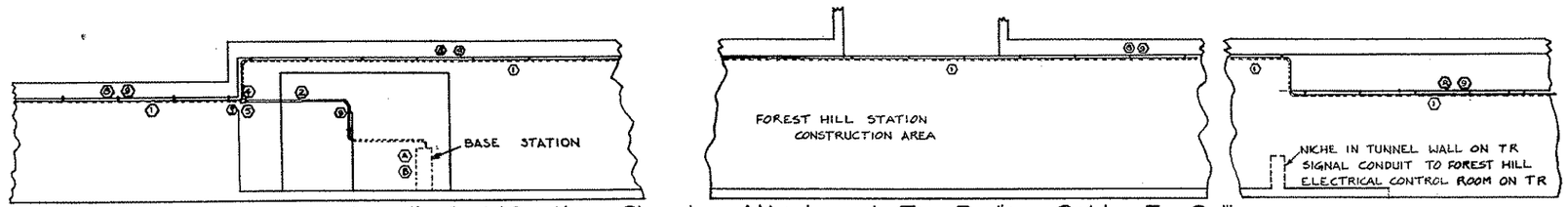
UHF RADIO SYSTEM FOR LRV
ANTENNA & BASE STATION NO. 5
EUREKA STATION

RECOMMENDED: E. Yakaki — BY: R.a.S. — TR. — SCALE: NONE
APPROVED: Manuel Vieira — DIR. R.A. ISBERG — DATE: 11-11-75
APPROVED: Gene M. Duarte, Works, GENERAL MANAGER — DRAWING NO. CL-5861 — REVISION NO. 2

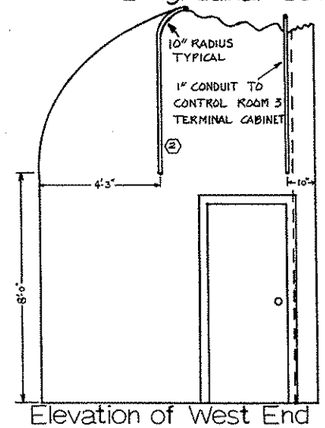
SHEET 1 OF 1 SHEETS

PRINTED ON GILPO NO. 1000N CLEARPRINT 4-74

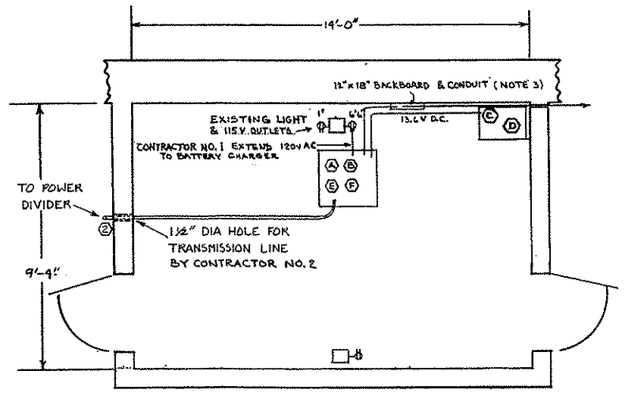

SEE NOTE 1 { 80 dB COUPLING LOSS TO LRV ANTENNA
2 dB CABLE LOSS TO LRV RECEIVER
RECEIVED LEVEL 79.2 dBm
SEE NOTE 2 36.9 dB SIGNAL MARGIN ABOVE 12 dB SINAD
2.82 dBm
2485' RADIAX 1.5 dB/100' LOSS -40.28dB LOSS
43.1 dBm
3.1dB
43.1 dBm
3525' RADIAX 1.5 dB/100' LOSS
52.9 dB TOTAL LOSS -9.8 dBm
SEE NOTE 1 { 80 dB COUPLING LOSS TO LRV ANTENNA
2 dB CABLE LOSS TO LRV RECEIVER
RECEIVED LEVEL — 72 dBm
SEE NOTE 2 24 dB SIGNAL MARGIN ABOVE 12 dB SINAD
0.6dB LOSS
46.2 dBm
47.8dBm TRANSMITTER CH.A 40W
46.8dBm DUPLEXER
RECEIVER
Schematic Diagram of R.F. System Including Signal Levels.
ENTRANCE TO WEST PORTAL OF TWIN PEAKS TUNNEL AT ULLOA STREET
2485'
300'
150'
3075'
END OF RADIAX CABLE FROM EUREKA
RADIO BASE STATION LOCATION NO. 4
FOREST HILL STATION (TO BE DEMOLISHED & REBUILT IN FUTURE)
DEMOLITION & CONSTRUCTION AREA FOR FUTURE F.H. STATION
CONTRACTOR NO.1 INSTALL 1" CONDUIT TO TELCO (NOTE 3).
WESTBOUND TRACK
EASTBOUND TRACK
Plan View of Radiating Cable System
DEMOLITION & CONSTRUCTION AREA FOR NEW WEST PORTAL STATION (WORK IN PROGRESS)
ELECTRICAL CONTROL ROOM 3 SEE REFERENCE SHEET DL5097
POWER CONDUIT (EXISTING)
TL
TR
SIGNAL CONDUIT (EXISTING)
ELEV. 1
CROSS SECTION OF TWIN PEAKS TUNNEL FROM EUREKA TO WEST PORTAL
ANTENNA AS REQUIRED
TELCO
10'
2½" PVC SCHEDULE 80 CONDUIT TO PROTECT FEED LINE FROM TROLLEY POLES.
ELEV. 2
CROSS SECTION OF WESTERN END OF FOREST HILL STATION
ELEV. 3
CROSS SECTION OF TWIN PEAKS TUNNEL FACING EAST


BASE STATION
FOREST HILL STATION CONSTRUCTION AREA
NICHE IN TUNNEL WALL ON TR
SIGNAL CONDUIT TO FOREST HILL
ELECTRICAL CONTROL ROOM ON TR

Longitudinal Sections Showing Attachment For Radiax Cable To Ceilings



Elevation of West End Wall of Radio Room


19'-0"
12"x18" BACKBOARD & CONDUIT (NOTE 3)
EXISTING LIGHT & 115 V. OUTLETS
CONTRACTOR NO.1 EXTEND 120V AC TO BATTERY CHARGER
13.6 V D.C.
TO POWER DIVIDER
1½" DIA HOLE FOR TRANSMISSION LINE BY CONTRACTOR NO. 2
9'-9"

Plan View of Radio Room

NOTES:
1. TYPICAL COUPLING LOSS AND CABLE LOSS APPLY TO DWGS. CL-5860 THROUGH CL-5865 EXCEPT WHERE EXPLICITLY NOTED OTHERWISE.
2. 12 dB SINAD LEVEL REFERENCED TO −116.1 dBm.
3. CONTRACTOR NO.1 INSTALL BACKBOARD & 200' CONDUIT TO TELCO TERMINAL CABINET (GROUND LEVEL).

ITEM	QTY.	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
①	6210'	RADIATING CABLE, ANDREW RADIAX RX5-1R	3.01
②	50'	FEEDER CABLE, ANDREW 7/8" LDF5-50 HELIAX, FOAM DIELECTRIC	3.06
③	1	POWER DIVIDER, ANDREW 42152 50 OHM, 50%-50%	6.01
④	2	CONNECTOR, ANDREW 45 AW, 7/8" RADIAX CABLE TO TYPE N MALE	5.01
⑤	2	CONNECTOR, ANDREW 45 AN, 7/8" RADIAX CABLE TO TYPE N FEMALE	5.01
⑥	1	CONNECTOR, ANDREW L45W, 7/8" LDF5-50 TO TYPE N MALE	5.02
⑦	1	CONNECTOR, ANDREW L45N, 7/8" LDF5-50 TO TYPE N FEMALE	5.02
⑧	780	ANCHOR FOR CONCRETE SURFACES, DIAMOND 01404	8.01
⑨	780	CABLE CLAMP FOR 7/8" CABLES, FOR ATTACHING TO CONCRETE ANCHOR, STAINLESS STEEL, ANDREW 40785-2	8.01
⑫	1	ANTENNA ON GROUND PLANE	7.01

ITEM	QTY.	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 629R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R SPEC. SECTION
Ⓐ	1	RADIO BASE STATION, 60 WATTS OUTPUT	5.28 5.21.02
Ⓑ	1	DUPLEXER	5.21.05
Ⓒ	2	STORAGE BATTERIES, 6 VOLT, 100 A.H. GLOBE TEL CELL 3 DY13	5.09.05
Ⓓ	1	BATTERY RACK, TRAY AND DRIP PAN	5.09.05
Ⓔ	1	BATTERY CHARGER RATELCO VF 12203R, 12v, 20A	5.09.05
Ⓕ	1	ALARM UNIT	5.18

CONTRACT NO. M.R. 648 & 629-R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM FOR LRV
ANTENNA & BASE STATION NO. 4
FOREST HILL STATION

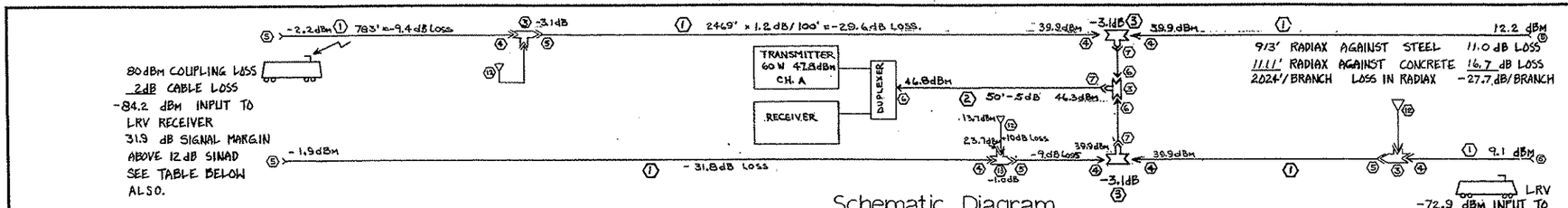
NO.	DATE	DESCRIPTION	BY	APP'D.
1	1-26-76	ADDED RADIATING ANTENNAS	R.A.T.	J.F.
2	5-10-76	DELETED ANTENNA IN FOREST HILL ANNEX, ADD'L TR. DR.	R.A.T.	J.F.
3	5-12-77	CONFORMED TO M.R. 629 R & M.R. 648	R.A.T.	

REVISIONS

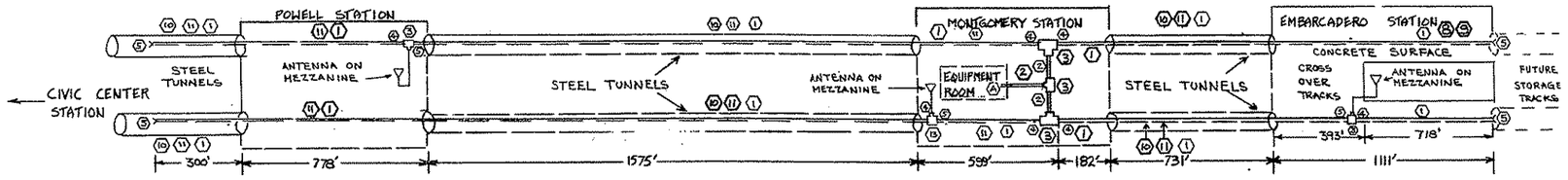
RECOMMENDED: S. Takaki — BY: R. Tatum — DR. SA 5860 — TR. — SCALE: NONE — DATE: 11-7-75
APPROVED: Louis Bue — Mgr. Telecommunications
APPROVED: George M. Duste — Deputy GENERAL MANAGER
DRAWING NO. CL-5860 — REVISION NO. 3

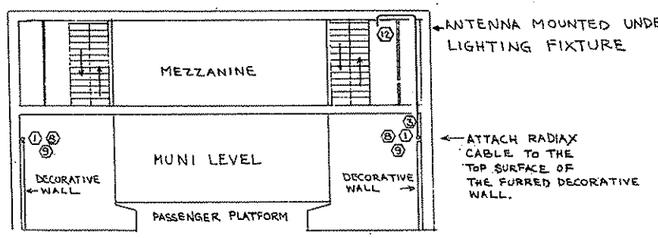
SHEET 1 OF 1 SHEETS

PRINTED ON DIEMO NO. 1000H CLEARPRINT 4-74

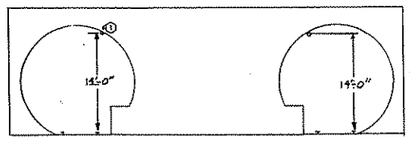


Schematic Diagram

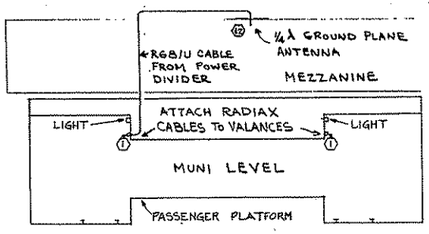




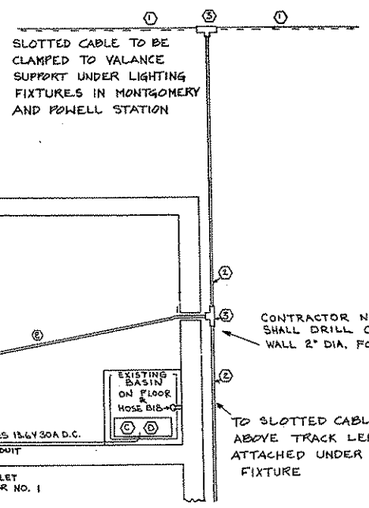
SECTION THROUGH WESTERN END OF EMBARCADERO STATION



TWIN STEEL TUBES EMBARCADERO TO POWELL



SECTION THROUGH MONTGOMERY & POWELL SHOWING MOUNTING FOR SLOTTED COAXIAL


SLOTTED CABLE TO BE CLAMPED TO VALANCE SUPPORT UNDER LIGHTING FIXTURES IN MONTGOMERY AND POWELL STATION
TO TELCO PANEL IN ROOM A207. SEE AL-2783
PLAN VIEW MONTGOMERY STATION BATTERY ROOM USED FOR BASE STATION
FLOOR DRAIN
SKIM CABINET BASE TO LEVEL.
EQUIPMENT ROOM B207
CONTRACTOR NO.1 INSTALL 90' 1" CONDUIT TO TELCO CABINET IN ROOM A207 & 12" x 18" BACK BOARD
2 #10 WIRES 13.6V 30A D.C. IN 1/2" CONDUIT
EXISTING BASIN ON FLOOR & HOSE BIB-C
FAN ROOM 210
EXTEND 120V AC FROM EXISTING OUTLET TO BATTERY CHARGER BY CONTRACTOR NO. 1
CONTRACTOR NO. 2 SHALL DRILL CEMENT BLOCK WALL 2" DIA. FOR 4
TO SLOTTED CABLE ABOVE TRACK LEFT ATTACHED UNDER LIGHTING FIXTURE

COMPUTATION OF SIGNAL STRENGTH RECEIVED AT BASE STATION FROM HAND HELD TRANSCEIVER NEAR END OF RADIAX CABLE AT POWELL STATION	
COUPLING LOSS BETWEEN TRANSCEIVER 100' FROM RADIAX CABLE.	-90 dB
ATTENUATION OF 3252' RADIAX CABLE	-39.2 dB
ATTENUATION OF POWER DIVIDERS	- 6.2 dB
ATTENUATION OF 100' FOAM HELIAX FEEDER CABLE	-0.9 dB
DUPLEXER LOSS	1.0 dB
TOTAL LOSSES	-137.3 dB
EFFECTIVE RADIATED POWER FROM 3.5 WATT TRANSCEIVER	+35.4 dBm
INPUT SIGNAL TO BASE STATION RECEIVER	-101.9 dBm
SIGNAL MARGIN ABOVE 12 dB SINAD	14.2 dB
THE SIGNAL LEVEL SHOULD BE APPROXIMATELY 15 dB GREATER AT THE EMBARCADERO STATION.	

ITEM	QTY.	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT M.R. 648 BY CONTRACTOR NO. 2	CONTRACT M.R. 648 SPEC. SECTION
1	10550'	RADIATING CABLE, ANDREW RADIAX RXS-1R	3.01
2	100'	FEEDER CABLE, ANDREW 7/8" LDF5-50 HELIAX FOAM DIELECTRIC	3.06
3	5	POWER DIVIDER, ANDREW 42152 50 OHM, 50%-50%	6.01
4	8	CONNECTOR, ANDREW 45 AW 7/8" RADIAX CABLE TO TYPE N MALE	5.01
5	8	CONNECTOR, ANDREW 45 AN 7/8" RADIAX CABLE TO TYPE N FEMALE	5.01
6	3	CONNECTOR, ANDREW L45W, 7/8" LDF5-50 TO TYPE N MALE	5.02
7	3	CONNECTOR, ANDREW L45N, 7/8" LDF5-50 TO TYPE N FEMALE	5.02
8	275	ANCHOR FOR CONCRETE SURFACES DIAMOND 01404	8.01
9	1350	CABLE CLAMP FOR 7/8" CABLES ATTACHED TO 8 AND TO VALANCES, STAINLESS STEEL, ANDREW 40785-2	8.01
10	651	CLAMP FOR ATTACHING TO METAL I BEAMS, STAINLESS STEEL, ANDREW 31768A-2	8.02
11	651	CABLE CLAMP FOR 7/8" CABLES SPACED FROM STEEL SURFACES, MOLDED PLASTIC SPACER, ANDREW 36719	8.02
12	3	ANTENNA ON GROUND PLANE	7.01
13	1	POWER DIVIDER, TELE-WAVE 80%-20%, 50 OHM IMPEDANCE	6.02

ITEM	QTY	MATERIAL TO BE FURNISHED AND INSTALLED UNDER CONTRACT NO. M.R. 629R BY CONTRACTOR NO. 1	CONTRACT M.R. 629R SPEC.
A	1	RADIO BASE STATION, 60 WATTS OUTPUT	5.24 5.21.02
B	1	DUPLEXER	5.21.05
C	2	STORAGE BATTERIES, 6 VOLT, 100 A.H. GLOBE TEL CELL 3 GY 13	5.09.05
D	1	BATTERY RACK	5.09.05
E	1	BATTERY CHARGER	5.09.05
F	1	ALARM UNIT	5.18

COMSUL LTD.
417 MONTGOMERY ST.
SAN FRANCISCO, CA 94104

REGISTERED PROFESSIONAL ENGINEER R. A. ISBERG No. 731 ELECTRICAL STATE OF CALIFORNIA

NO.	DATE	DESCRIPTION	BY	APP'D.
2	5/11/77	CHANGED CONTRACT NO. & DELETED CH.C	RAI.	
1	12/1/76	ADDED RADIATING ANTENNAS Crossed out 2 to 5	RAI.	

REVISIONS

CONTRACT NO. M.R. 648 & 629-R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM FOR LRV
ANTENNA & BASE STATION NO.9
MONTGOMERY STATION

RECOMMENDED S. Yakaji BY Sealey TR. SCALE N.S.
APPROVED Nino Ricci DR. D. Olivier CH. R.A.I. DATE 11-20-75
APPROVED Roger M. Duarte Deputy GENERAL MANAGER
DRAWING NO. CL-5865 REVISION NO. 2

SHEET 1 OF SHEETS

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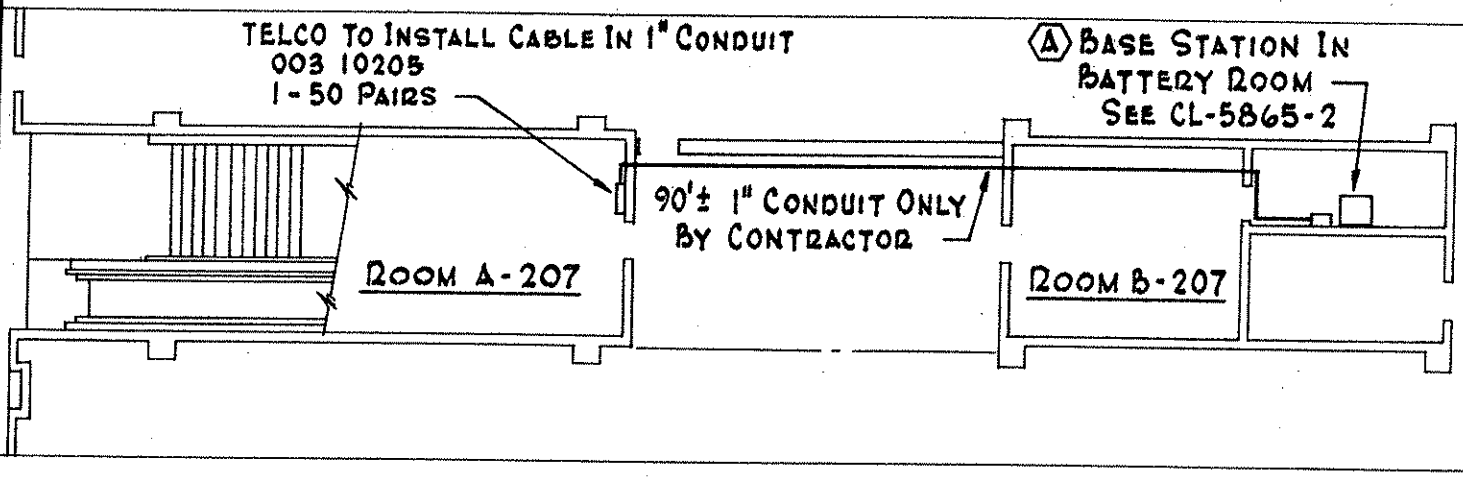


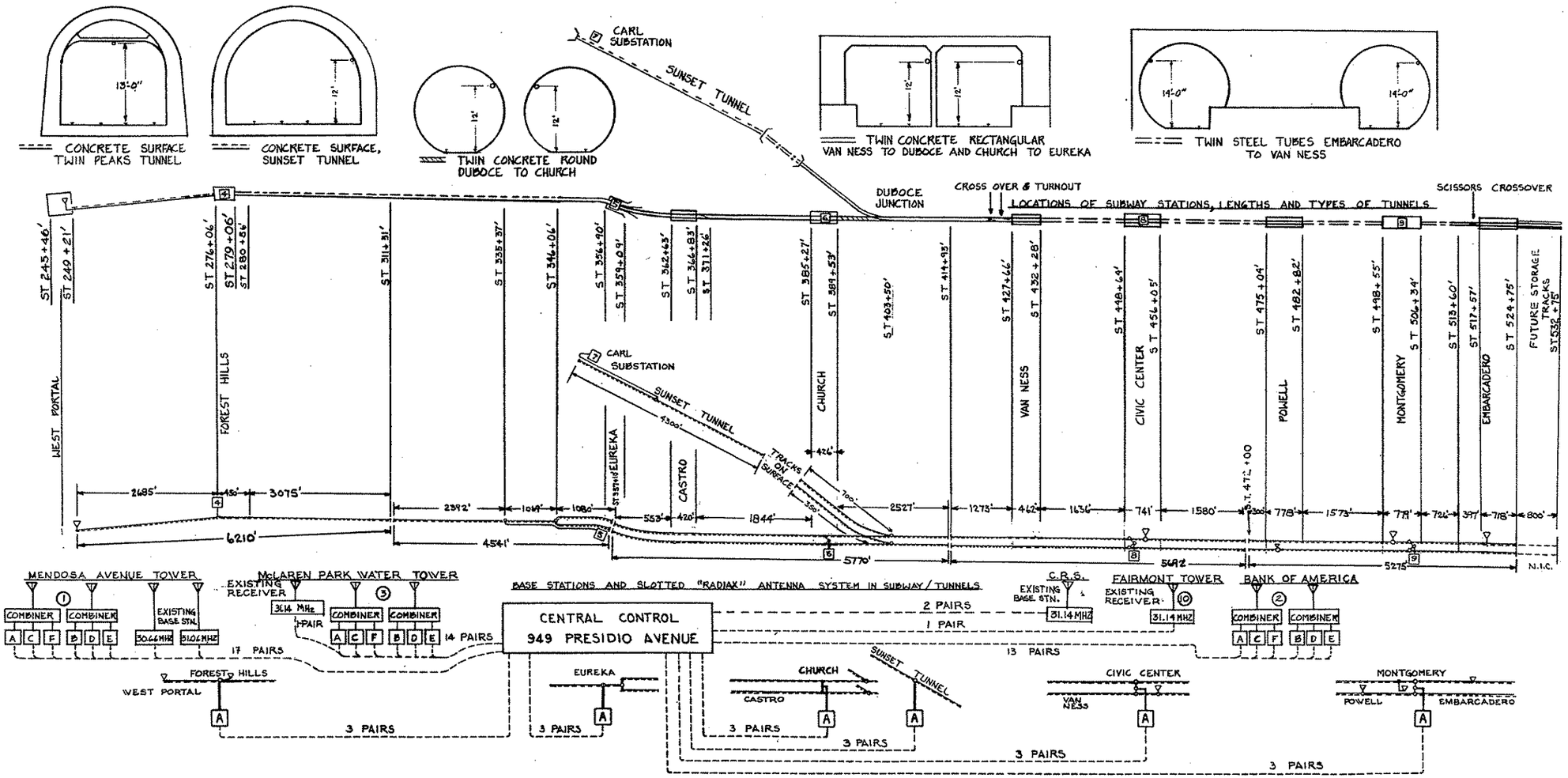
CONTRACT NO. MR-629-R

CITY AND COUNTY OF SAN FRANCISCO — PUBLIC UTILITIES COMMISSION

SAN FRANCISCO MUNICIPAL RAILWAY

UHF RADIO SYSTEM FOR LRV
BASE STATION
MONTGOMERY STATION

BY SY	TR. BTI	APPROVED W. Molinari for Public Utilities Commission	SCALE NONE	DATE JUNE 29, '77	LATEST REVISION
DR. BTI	CH. S.Y.	APPROVED George R. Dean Deputy GENERAL MANAGER		DRAWING NO. AL-2983	REVISION NO. 0
RECOMMENDED S. Yakahi					



SIMPLIFIED BLOCK DIAGRAM OF MUNI RADIO SYSTEM

LEGENDS

- (2) BASE STATION LOCATION NUMBER ABOVE GROUND.
- (2) BASE STATION LOCATION NUMBER IN SUBWAY/TUNNEL.
- SEGMENT OF SLOTTED ANTENNA SYSTEM IN SUBWAY/TUNNEL (MR-648).
- [A] BASE STATION RADIO CHANNEL ASSIGNED.
- ANTENNA ABOVE GROUND (MR-629-R).
- ANTENNA IN SUBWAY STATION (MR-648).
- C.R.S. CENTRAL RADIO STATION, CHRISTMAS TREE POINT.
- RADIO CONTROL LINES - TWO WIRE, 3002 SCHEDULE 4, DATA/VOICE GRADE, LEASED.
- SLOTTED "RADIAX" ANTENNA SYSTEM IN SUBWAYS AND POWER DIVIDER (MR-648).
- COAXIAL FEED LINE TO SLOTTED ANTENNA SYSTEM (MR-648).

CONTRACT NO. M.R. 648 & 629R

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
SAN FRANCISCO MUNICIPAL RAILWAY

U/G WAYSIDE COMMUNICATIONS AND COMPOSITE RADIO SYSTEM DIAGRAM

PROFESSIONAL ENGINEER R.A.T. DE SILVA No. 721 ELECTRICAL STATE OF CALIFORNIA

CONSUL LTD.
417 MONTGOMERY ST.
SAN FRANCISCO, CA 94101

NO.	DATE	REVISIONS	BY	APPR'D.
3	5/4/77	DELETED CH-C IN SUBWAY AND MUNI CONTROL CABLES	R.A.dS.	
2	3/7/74	DELETED ANTENNAS, VAN NESS, CHURCH CABLE & REVISED MULTI COND. CABLE & TELCO REQ.	R.A.dS.	
1	1/18/74	ADDED ANTENNAS IN SUBWAY STATIONS	R.A.dS.	

RECOMMENDED	S. Yokahi	TR.	
APPROVED		SCALE	NONE
CHIEF R.A.T. DE SILVA		DATE	11-7-75
APPROVED	GENERAL MANAGER	DRAWING NO.	CL-5859
		REVISION NO.	3

SHEET 1 OF 1 SHEETS

PRINTED ON CHEMO NO. 1000K CLEARPRINT 4-74

appendix **twenty-one**

SFMTA Planned Talk Group Listing

for reference only

Revision History

Revision	Date	Change	Approval
0	12/04/2009	Release for RFQ/RFP	n/a

Appendix 21
SFMTA's Planned Talkgroup List (Hypothetical)

Talkgroup No.	Department	Talkgroup Label - Description
1	Cable Car Service	Cable Car Administration
2	Cable Car Service	Cable Car Machinery 1
3	Cable Car Service	Cable Car Machinery 2
4	Cable Car Service	Cable Car Primary
5	Cable Car Service	Cable Car Supervisors
6	Metro Rail Service	Rail Administration
7	Metro Rail Service	Rail Inspector 1
8	Metro Rail Service	Rail Inspector 2
9	Metro Rail Service	Rail Primary
10	Metro Rail Service	Rail Secondary
11	Metro Rail Service	Rail Underground
12	Metro Rail Service	Station Agents
13	Operational Control Center	Bus 1 (CAD Controlled)
14	Operational Control Center	Bus 2 (CAD Controlled)
15	Operational Control Center	Bus 3 (CAD Controlled)
16	Operational Control Center	Bus 4 (CAD Controlled)
17	Operational Control Center	Bus 5 (CAD Controlled)
18	Operational Control Center	Bus 6 (CAD Controlled)
19	Operational Control Center	Line Management 1
20	Operational Control Center	Line Management 2
21	Operational Control Center	Trolley 1 (CAD Controlled)
22	Operational Control Center	Trolley 2 (CAD Controlled)
23	Operational Control Center	Trolley 3 (CAD Controlled)
24	Rubber Tire Service Operations	Bus Inspector - Downtown
25	Rubber Tire Service Operations	Bus Inspector - North
26	Rubber Tire Service Operations	Bus Inspector - South
27	Rubber Tire Service Operations	Bus Inspector - West
28	Rubber Tire Service Operations	Bus Maintenance 1
29	Rubber Tire Service Operations	Bus Maintenance 2
30	Rubber Tire Service Operations	Fleet Administration
31	Rubber Tire Service Operations	Non-revenue Maintenance
32	Rubber Tire Service Operations	Service Planning
33	Rubber Tire Service Operations	Trolley Maintenance 1
34	Rubber Tire Service Operations	Trolley Maintenance 2

35	SFMTA Operations	Citywide 1
36	SFMTA Operations	Citywide 2
37	SFMTA Operations	Citywide 3
38	SFMTA Operations	Citywide 4
39	SFMTA Operations	Citywide 5
40	SFMTA Operations	DPT Common
41	SFMTA Operations	Engineering 2
42	SFMTA Operations	Engineering 1
43	SFMTA Operations	Facility Maintenance 1
44	SFMTA Operations	Facility Maintenance 2
45	SFMTA Operations	Fair Enforcement 1
46	SFMTA Operations	Fair Enforcement 2
47	SFMTA Operations	Fair Enforcement 3
48	SFMTA Operations	Information Technology 1
49	SFMTA Operations	Information Technology 2
50	SFMTA Operations	Radio Maintenance
51	SFMTA Operations	Security 1
52	SFMTA Operations	Security 2
53	SFMTA Operations	Security 3
54	SFMTA Operations	SFMTA Common 1
55	SFMTA Operations	SFMTA Common 2

PERS Planned Talkgroup List

Talkgroup No.	Department	Talkgroup Label - Description
1	Department of Public Health	DPH - Operations
2	Department of Public Health	DPH-Administration
3	Department of Public Health	SFGH - Engineering
4	Department of Public Health	Laguna Honda Hospital Police Department
5	Department of Public Health	Laguna Honda Hospital Administration
6	Unified School District	USD 1
7	Unified School District	USD 2
8	Unified School District	USD 3
9	Unified School District	USD 4
10	Department of Public Works	C-AND-E-2 - Construction &Engineering - 2
11	Department of Public Works	DBI-2 - Bureau of Inspection
12	Department of Public Works	DBI-1 - Bureau of Inspection
13	Department of Public Works	BERM - Environmental Regulation
14	Department of Public Works	WPC-SO - Sewer Operation
15	Department of Public Works	WPC-OM - Operation and Maintenance
16	Department of Public Works	14-SSR-2 - Street and Sewer
17	Department of Public Works	13-BSES-4 - Street Cleaners
18	Department of Public Works	13B-BSES-4 - Street Cleaners*
19	Department of Public Works	12-BBR-2 - Building Repair
20	Department of Public Works	11-BSM/EHS - Street Mapping

Talkgroup No.	Department	Talkgroup Label - Description
21	Department of Public Works	11B-BSM/EHS - Street Mapping*
22	Department of Public Works	10-SUPV-2 - Supervisor
23	Department of Public Works	9-SUPV - Supervisor
24	Department of Public Works	8-EMGCY - Emergency Channel
25	Department of Public Works	7-BE/BM/BA - Engineering Groups
26	Department of Public Works	6-BUF - Urban Forestry
27	Department of Public Works	6A-BUF - Urban Forestry*
28	Department of Public Works	5-BSES-2 - Street Cleaners
29	Department of Public Works	5B-BSES-2 - Street Cleaners*
30	Department of Public Works	5C-BSES-2 - Street Cleaners*
31	Department of Public Works	5D-BSES-2 - Street Cleaners*
32	Department of Public Works	4-BBR - Building Repair
33	Department of Public Works	4B-BBR - Building Repair*
34	Department of Public Works	3-SSR - Street and Sewer
35	Department of Public Works	2-BSES - Street Cleaners
36	Department of Public Works	2B-BSES - Street Cleaners*
37	Department of Public Works	2C-BSES - Street Cleaners*
38	Department of Public Works	1-CONTROL - Flag Ship Channel
39	Department of Public Works	1B-CONTROL - Flag Ship Channel*
40	Department of Public Works	1C-CONTROL - Flag Ship Channel*
41	Department of Public Works	1D-CONTROL - Flag Ship Channel*
42	Department of Public Works	C-AND-E-1 - Construction & Engineering - 1
43	Department of Public Works	10-ENGR 3 - Engineering Groups
44	Miscellaneous	MAP
45	Miscellaneous	ADULT-1 - Adult Probation
46	Miscellaneous	ANIMAL - Animal Care and Control
47	Miscellaneous	SPECIAL - Administration Services
48	Miscellaneous	OPERATION - Administration Services
49	Miscellaneous	FARMERS - Farmers Market
50	Miscellaneous	SFDA-1 - District Attorney
51	Miscellaneous	CCSF-1 - City College
52	Miscellaneous	RADIO-1 - Telephone & Information Services
53	Miscellaneous	RADIO-2 - DTIS
54	Miscellaneous	PORT/ADMIN - Pier Administration
55	Miscellaneous	PORT/MAINT - Pier Workers
56	Miscellaneous	AWSS - Fire High Pressure
57	Miscellaneous	AWSS2 - Fire High Pressure*
58	Miscellaneous	PD/ADMIN - Police
59	Miscellaneous	JUV/ADMIN - Juvenile

* New planned talkgroup

appendix **twenty-two**

Rail Vehicle Material and Workmanship

Revision History

Revision	Date	Change	Approval
0	12/04/2009	Release for RFQ/RFP	n/a

Appendix 22
MATERIALS AND WORKMANSHIP

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Appendix 22
MATERIALS AND WORKMANSHIP FOR RAIL VEHICLES

22.1 GENERAL

22.1.1 Quality

Material and workmanship shall be in accordance with the stated Specification or description, unless written approval for substitution is obtained.

Inclusion of a material or method in this section does not indicate approval for application or use in a specific situation. When a material or method is specified in this section, this section shall be applicable; however, specific requirements detailed in appropriate Technical Specifications sections take precedence over this section.

22.1.2 Standards

The following domestic standards and specifications define materials for this contract: Federal or Military Specifications or Standards, the Specifications of the Aluminum Association of America, AAR, ANSI, ASME, ASTM, FRA, IEEE, and additional requirements, as specified herein. Where other or foreign standards are proposed by the Contractor, the Contractor shall submit documentation for SFMTA review and approval demonstrating that the proposed standards are the equivalent of the foregoing standards and specifications. Proposed substitute specifications shall be submitted in both English and the language of the country of origin.

22.2 JOINING AND FASTENING

22.2.1 Joining

22.2.1.1 General

Certain combinations of materials require particular care in joining to avoid the possibility of corrosion. Isolating and moisture-proofing materials, appropriate to the materials being joined, shall be used at all times where these combinations exist.

22.2.1.2 Joint Fitting

Joints shall be properly fitted, whether exposed or concealed. When not otherwise specified in drawings or specifications, gaps between joints shall be held to a dimension not greater than 10% of the thinner material being joined, or 0.002-inch (0.05-mm), whichever is greater. Gaps shall be uniform in width. The edges of panels shall have a smooth, finished appearance.

Where excessive gaps (greater than those permitted by approved drawings or standards) are found to exist at the faying surfaces of structural bolted or riveted connections, metal shims of the same material as that of the deficient part may be used, but only with the written permission of SFMTA. Shims, if used, shall be permanently fastened to one of the base parts being joined. The use of epoxy or other plastic filler at such locations is expressly prohibited.

22.2.1.3 Metal-to-Metal Connections

Where metals contact each other, the contact surfaces shall be free of dirt, grease, rust, and scale. Unless specified otherwise, the contact surfaces shall be coated with a metal based primer that conforms to Society for Protective Coatings Specification SSPC-Paint 25. Metal primer may be omitted for like-stainless steel to like-stainless steel joints.

Dissimilar metal protection shall be applied where necessary to prevent metal corrosion. Where dissimilar metals are joined using mechanical fasteners, the joint shall be protected against electrolytic corrosion. Joining of dissimilar metals is subject to specific SFMTA approval.

For proper treatment of a connection involving aluminum, refer to Section 22.6.4.

22.2.1.4 Wood-to-Metal Connections

Where wood and ferrous metal surfaces are placed together, the wood shall be coated with aluminum paint conforming to Federal Specification TT-P-38, and the metal shall be coated with a primer that conforms to Society for Protective Coatings Specification SSPC-Paint 25.

Unless otherwise approved, all bolts or rods passing through wood shall be coated with aluminum paint conforming to Federal Specification TT-P-38.

22.2.1.5 Wood-to-Wood Connections

Where wood and wood are placed together, both abutting surfaces shall be coated with aluminum paint conforming to Federal Specification TT-P-38.

22.2.2 Fasteners

22.2.2.1 General

The Contractor and suppliers are responsible for selecting fastener types, sizes, styles, lengths, materials, grades, and finishes that will meet the requirements of this Specification. The Contractor shall minimize the number of different sizes and styles of fasteners used.

Fasteners used throughout the car shall be inch standard fasteners, except that ISO Metric fasteners may be used in conformance with Section 22.2.2.2.2. Cadmium plated fasteners shall not be used.

All fasteners used on this vehicle can be classified under one of four categories: critical; general purpose; decorative; or electrical and electronic. The criteria for classification are expressed below. All fasteners must meet the general requirements for design and material in addition to any requirements contained in the section specific to the particular category. All fasteners, in any category, which attach to car structure, shall be in accordance with Section 10.3.

Critical fasteners include, but are not limited to, all fasteners applied to carbody structure, trucks, bolsters, truck-mounted brake equipment, couplers, and power collection devices. Additionally, any fastener is considered critical if failures cannot be tolerated, that is, if even a

single fastener fails there is a possibility of brake failure, derailment, or accident. In the event of a dispute, SFMTA shall be the final arbitrator on which fasteners are classified as critical.

Fasteners used to attach interior lining or trim and exposed to passenger view are specified under Decorative and Appearance Fasteners.

Fasteners used to secure wire terminations to an electrical or electronic device are considered electrical and electronic, and are specified in appropriate Materials and Workmanship subsections for electrical devices and wiring.

Fasteners not falling into one of the other three categories are classified as general purpose.

Detailed requirements pertaining to critical, general purpose and decorative fasteners are listed below.

22.2.2.2 Threaded Fastener Standards

22.2.2.2.1 Inch-Standard Fasteners

All inch-standard threaded fasteners shall conform to ANSI B1.1 Standard, Unified Inch Screw Threads, (UN and UNR Thread Form) or Industrial Fasteners Institute Fastener Standards.

22.2.2.2.2 Metric Fasteners

Upon approval, specific Line Replacement Units (LRUs) that are provided to the Contractor by a supplier or subsupplier may be supplied with metric fasteners to ANSI B1.13M (ISO-metric) Standards. In these cases, all internal fasteners and threaded components of the approved unit shall have ISO-metric threads. Internal to components there shall be no mixing of metric and inch threaded fasteners. External mounting fasteners and threaded connecting components shall have ISO-inch threads to ANSI B1.1 Standards. Each unit, component, or group containing ISO-metric threads shall be indelibly identified, in an approved manner and in a conspicuous approved location, to signify that the unit contains metric threaded fasteners. All repair and maintenance manuals shall be conspicuously marked on each page where metric threaded fasteners were used within the unit. Replacement, repair, or maintenance parts supplied under this Specification shall contain all necessary replacement fasteners of the correct size and grade.

Metric fasteners shall be marked as required in "Metric Fastener Standards," Industrial Fasteners Institute, latest edition.

22.2.2.3 General Requirements

22.2.2.3.1 Fastener Materials and Coatings

When making connections to heat producing apparatus, thermal expansion of the components shall be taken into consideration for selection of fastener materials. If the joined components are high expansion alloys such as copper or austenitic stainless

steel, austenitic stainless steel fasteners shall be used. If the joined components are low expansion materials such as carbon steel or Ferritic stainless steel, zinc plated carbon steel fasteners of minimum Grade 5 shall be used.

All carbon, alloy, and martensitic stainless steel fasteners shall be plated with zinc, unless specifically waived by SFMTA. Cadmium plated fasteners are not permitted. Grade 8 or metric grade 10.9, or stronger, fasteners shall not be plated if the OEM finish is other than plating. The zinc plating thickness shall conform to ASTM B633 SC2, SC3, SC4 or ASTM B695, Class 8. The zinc plating shall meet the salt spray requirements of ASTM B695, Class 8, Type I.

22.2.2.3.2 Alternate Coatings

Alternate fastener coatings are permissible if qualified by testing per ASTM B117 with no red rust after 72 hours of exposure. The Contractor shall submit qualification results for each process used at each subcontractor applying the proposed coating.

In order to use an alternate coating, the Contractor shall submit:

A. The coating manufacturer's product data including required thickness

B. ASTM B117 test results from an accredited third party laboratory

C. Documentation of torque/tension characteristics

D. A statement from the coating manufacturer regarding the propensity for the coating process to cause hydrogen embrittlement of the fastener during coating.

Regardless of the coating's propensity for hydrogen embrittlement, each lot of high strength fasteners (Grade 5 or Metric Grade 8.8 or higher) shall be tested for hydrogen embrittlement in accordance with Section 22.2.2.3.7. Each lot of lower strength fasteners shall be tested for hydrogen embrittlement if the coating has the possibility of causing hydrogen embrittlement.

If the proposed coating results in a change in the K-value for the plated fastener, as defined by Industrial Fasteners Institute Standard IFI-543, outside the range of 0.13-0.15, the vendor shall use the alternate coating on all fasteners within the particular LRU. The LRU shall contain an indelible label identifying the coating type used within the LRU and the required torque values for each size fastener used therein. Fasteners internal to a subcomponent within an LRU may use the standard coating system if they are not subject to removal during Owner's maintenance activities.

22.2.2.3.3 Requirements for Nuts

All nuts shall be of a grade, class, and material (including plating) compatible with the mating fastener. Inch standard nuts shall conform to ANSI/ASME B18.2.2 for diameters of 1/4-inch and larger, and ASNI/ASME B18.6.3 for diameters less than 1/4-inch. Metric nuts shall conform to ANSI B18.2.4.1M or ANSI B18.2.4.2M.

Unless otherwise required by a specific application, all nuts shall be regular height, nylon insert, self-locking stop nuts (ESNA or approved equal), conforming to Military Standard MS-21044 and Military Specification MIL-N-25027. Where nylon-insert self-locking stop nuts cannot be used, self-locking bolts and screws conforming to MIL-DTL-18240 Type L may be used. Nylon insert lock nuts, bolts, or screws shall not be used near heat sources that shall exceed the manufacturer's recommended operating temperature or 200°F, whichever is lower.

All metal prevailing-torque type locknuts shall only be used where there is insufficient clearance to install ESNA type locknuts, or where the locknut is exposed to temperatures above 200°F (93°C).

All carbon, alloy, and martensitic stainless steel nuts shall be plated with zinc, unless specifically waived by the Engineer. Grade B or metric grade 10.9, or stronger, nuts shall not be plated if the OEM finish is other than plating. The zinc plating shall conform to ASTM B633, SC2 Type I, SC3 Type I, or SC4 Type I, or ASTM B695, Class 8, Type I.

Alternate coatings may be applied to nuts per the requirements of Section 22.2.2.3.2.

22.2.2.3.4 Washers and Retention Devices

Washers, of a grade and strength compatible with the fastener, shall be used under the heads of all hex bolts, unless otherwise approved, and under all nuts. Washers shall conform to ANSI B18.22.1 or ANSI B18.22M, latest revision, as is appropriate for the application. Where high strength fasteners are applied, washers shall be hardened and comply with IFI Fastener Standards.

Lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. The use of lock washers is discouraged throughout the vehicle and all systems. Other types of washers, including Belleville washers, may be used for special applications with SFMTA's approval. Lock washers, when applied, shall conform to IFI Fastener Standards.

22.2.2.3.5 Joint Design

All screws or bolts used to secure access panels to the interior, undercar, or roof equipment shall be made captive to the panel in which they are used. All fasteners used to secure access covers, doors, or panels to equipment boxes or interior panels shall be made captive to the panel in which they are used. Where access for service is expected more often than every 5 years, access panels shall be equipped with quarter-turn fasteners. Quarter-turn fasteners shall have a minimum shank diameter of 0.25-inch (6 mm), be of adequate strength, and as manufactured by Southco, or approved equal.

Unless otherwise approved by SFMTA, threaded fasteners shall not be threaded directly into non-metallic materials. Metal thread inserts shall be used when a threaded fastener is secured to a non-metallic material.

When bolts are used to secure apparatus where the bolt head is not accessible, a reusable mechanical locking device shall be used to prevent the bolt head from turning when the nut is being turned.

At least 1-1/2 screw threads shall be visible beyond all nuts. When used without elastic stop nuts, bolts shall not project more than 1-1/2 threads plus 1/4-inch (6 mm) for bolts 1/4-inch (6 mm) diameter or less and shall not project more than 8 threads for larger diameter bolts, unless otherwise approved. With elastic stop nuts, bolt threads shall not project more than 1/4-inch (6 mm), regardless of bolt size.

Undercar equipment shall not be supported by bolts in tension.

22.2.2.3.6 Fastener Tightening and Torque

All critical fasteners and general purpose fasteners used to secure equipment to the carbody, including truck and brake equipment bolts and all fasteners exposed to fatigue loads, shall be torqued to a minimum preload equal to 75 percent of their proof load and "torqued striped" after torquing by paint or other approved means. All other fasteners shall be torqued to a value appropriate to the application, so that they do not loosen in service.

Fastener installation torque for standard oiled or waxed bolts with standard or heavy hex nuts may be calculated from Industrial Fasteners Institute, Fastener Standards, equations using values for "K" of 0.18 for unplated and 0.15 for plated threads. Fastener torque for bolts with alternate coatings shall be calculated using K values provided per Section 22.2.2.3.2. Locknuts shall be torqued in accordance with their manufacturer's recommendations or the Contractor may conduct tests to determine installation torque. For those nuts or bolts requiring "torque striping," SFMTA may require bolt torque-tension tests to verify that installed preload is equivalent to 75 percent of proof loads.

When necessary, alternate methods of determining fastener preload may be proposed for SFMTA's consideration.

22.2.2.3.7 Critical Fasteners

All critical fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by SFMTA at the Contractor's QA department. This documentation shall include the fastener material or grade, and finish including plating material and specifications, when applicable. Whether the buyer is a subcontractor, supplier, or the Contractor, the Contractor shall obtain and hold this documentation for a period of not less than termination of the last car's warranty period.

All critical fasteners shall either: (1) be manufactured, tested, and distributed in accordance with ASME FAP-1-1990, Quality Assurance Program for Fastener Manufacturers and Distributors, including the requirements of ASME accreditation; or (2) have a representative sample of each production lot of fasteners tested for

conformance to purchase specifications by an independent laboratory accredited by the American Association of Laboratory Accreditation (AALA), or approved equal.

A production lot is defined as one size of fastener, from one manufacturer, produced during one continuous production run. Fasteners not meeting this definition of production lot shall be treated as separate lots. Testing shall be performed using sample quantities as proposed by the Contractor and approved by SFMTA. Tests conducted shall confirm that fastener material meets specified chemistry and strength requirements. The Contractor shall obtain certified test results from the testing laboratory and hold the documents for a period of not less than the termination of the warranty period of the last car.

All critical fasteners that are plated or chemically cleaned shall have certifications showing freedom from hydrogen embrittlement. If non-standard, structural, or safety related fasteners are plated by other than the OEM; a representative sample of these fasteners shall be tested for hydrogen embrittlement by the Contractor or a supplier following ASTM F519 procedures. An ASTM F606 wedge test sample may be used in place of the F519 standard samples. Test loads shall be a minimum of 80 percent of yield strength or proof load and held for a minimum of 168 hours. Any failures shall reject the entire lot.

22.2.2.3.8 General Purpose Fasteners

Mounting and attachment bolts shall be sized to the design strengths for Grade 2 bolts and Class A nuts, however in no case shall the fastener diameter be less than 3/8-inch (10 mm), regardless of the design load. Grade 5 bolts and Class A nuts shall be used for installation of all equipment and/or structures. Pem-nuts, or similar friction-fit style fasteners, shall not be used anywhere on the railcar. Riv-nuts, or similar cinch-tight style of fasteners may be used only with specific permission from SFMTA.

Fasteners used within equipment shall meet all requirements of Section 22.2.2 (other than the requirements specifically listed for critical fasteners or decorative fasteners), and shall be sized as appropriate for the application.

All general purpose fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied, and the fastener type. The Contractor or supplier shall maintain this documentation on file for SFMTA to review for a period of not less than the expiration of the warranty on the last car delivered.

22.2.2.3.9 Decorative and Appearance Fasteners

All interior fasteners exposed to passengers shall be either bright or finished to match the surfaces being joined, and installed such that the fastener head is flush with the mating surface. Bright finished fasteners used for stanchions shall be austenitic grade stainless steel. Bright finished interior fasteners may be either austenitic or plated martensitic stainless steel. Self-tapping screws are only permitted where they shall not be removed for normal maintenance more frequently than once in five years and shall be plated martensitic stainless steel.

All exterior fasteners visible to passengers shall be austenitic stainless steel for steel, LAHT steel, and stainless steel car bodies. Exterior aluminum shall be joined by austenitic stainless steel or aluminum alloy fasteners, as appropriate to the design and appearance requirements. Fasteners used on the side sill to attach equipment brackets are considered either critical or general-purpose fasteners, as appropriate for the application.

Fasteners on access panels, plates, covers, or other components accessible by passengers shall be of a single style tamperproof type approved by SFMTA.

All decorative and appearance fasteners shall have documentation that identifies the manufacturer, base material, plating or finish if applied, and the fastener type. The Contractor or supplier shall maintain this documentation on file for SFMTA to review for a period of not less than the expiration of the warranty on the last car delivered.

22.2.2.4 Rivets and Lock Pins

Rivets and lock pins exposed to passengers shall be austenitic stainless steel or aluminum, as appropriate to the materials being joined. Structural steel rivets shall conform to ASTM-A-502 or ANSI B 18.1.2 standards. Rivets may be hand driven when hot and shall completely fill the rivet holes. Rivets driven cold shall be mechanically driven. Exposed heads shall be concentric with the shank and free from rings, fins, pits, and burrs.

Swage-locking (Huckbolt-type) fasteners shall conform to Military Specification MIL-P-23469. All rough surfaces of the collar end of these fasteners shall be machined or ground smooth where accessible to passengers, crew, or maintenance personnel performing routine maintenance functions. SFMTA shall be the final arbiter in determining whether an application is hazardous to maintenance personnel.

22.2.2.5 Rivet and Bolt Holes

Rivet and bolt holes shall be accurately located and aligned, and, when necessary during assembly, holes shall be reamed round to specified size in position. Bolt hole clearances shall not exceed the IFI's requirements. All removed and replaced rivets shall have the holes reamed to the size required such that the next larger rivet may be driven securely.

22.3 STAINLESS STEEL

22.3.1 General

Permitted uses of structural stainless steels are specified throughout this Specification. Ferritic stainless steels shall be painted where exposed to passengers or the weather. Austenitic stainless steels may be unpainted. Unpainted stainless steels exposed to passengers shall be a single grade of austenitic stainless steel in which both the color and surface finish of abutting pieces shall match, except where the design specifically calls for contrasting appearance.

22.3.2 Austenitic Stainless Steel

Structural austenitic stainless steel components assembled by fusion or resistance welding shall be of AISI-type 201L or 301L and shall conform to the requirements of ASTM-A-666 except that the carbon content shall not exceed 0.03% and type 301L shall not exceed 0.25% nitrogen. Other stainless steels conforming to ASTM A 666 are acceptable for non-welded applications.

Stainless steel used in structural applications covered by this Specification shall also conform to APTA Standard SS-C&S-004-98, "Standard for Austenitic Stainless Steel for Railroad Passenger Equipment."

General requirements for delivery of stainless steel shall be as required by the Certification Provisions of ASTM-A666, and stainless steel to be used in structural applications shall be tested for susceptibility to intergranular corrosion in accordance with ASTM A 262, latest revision. Practice A of ASTM-A-262 can be used to accept material only; Practice E is required for final determination of acceptance or rejection of material that is not acceptable by Practice A.

22.3.3 Ferritic Stainless Steels

When specified, Ferritic stainless steel conforming to ASTM-A-176 may be used for carbody structural sheeting up to 4 mm thickness. Ferritic stainless steel sheet shall have a ductile-to-brittle transition temperature (DBTT) or nil-ductility temperature (NDT) below 0°C. Weld heat-affected-zones shall also have a DBTT or NDT below 0°C. Ferritic stainless steel sheet shall have a balanced composition (low carbon and/or suitable titanium content) that will, for all conditions of fabrication and assembly into the carbody, inhibit formation of martensite and limit chromium depletion in weld-heat-affected zones so that material shall meet ASTM-A-736 requirements for resistance to intergranular corrosion.

General requirements for delivery of stainless steel shall be as required by ASTM-A-480.

Where Ferritic stainless steels are welded to other structural steels, the less-noble steel shall be painted with weld through primer.

22.3.4 Testing

The Contractor shall prepare (or have prepared), submit, and receive approval of a test and inspection plan for acceptance of all stainless steel to be used in welded applications prior to purchasing any such material. The tests and inspections shall verify that the stainless steel conforms to specified requirements. For austenitic stainless steels, the test and inspection plan shall include frequency of submittal of certifications in accordance with Certification Provision of ASTM A 666 and frequency of submittal of checks for susceptibility to intergranular corrosion in accordance with ASTM A 262. For Ferritic stainless steels, the test and inspection plan shall include frequency of submittal of checks for susceptibility to intergranular corrosion in accordance with ASTM A 763.

22.4 LOW-ALLOY, HIGH-TENSILE STEEL

22.4.1 General

Low-alloy high-tensile (LAHT) steel structural shapes, plates, and bars shall, as a minimum, conform to the requirements of ASTM A588, where available. Plate steel may alternatively conform to ASTM A710, Grade A, Class 1 or Grade C, Class 1. Where not available in A588, hot rolled or formed structural shapes conforming to ASTM A36 may be used for limited applications including equipment supports and jack pads. General requirements for delivery of LAHT shapes, plates, and bars shall be as required by ASTM A6. Welded LAHT steel shall develop 15 ft-lbs Charpy V Notch impact strength in the Coarse Grain Heat Affected Zone (CGHAZ), 1 mm from fusion area at -20°F (-29°C).

Cold and hot rolled LAHT sheet and strip shall, as a minimum, conform to the requirements of ASTM-A606, Type 4. General requirements for delivery of these products shall be as required by ASTM-A568.

Other low-alloy, high-tensile steels which meet or exceed the above minimum requirements may be used, provided their detailed specifications are submitted and approved as equivalent, or better material, for the proposed applications. All LAHT steels shall be applied according to their specification properties.

Requests by the Contractor for alternate materials will be considered. The Contractor shall provide detailed and specific information on the proposed alternate material, using a U.S.-recognized trade name or UNS number. Chemistry and properties shall be provided in English and SI Units.

22.4.2 Testing

The Contractor shall prepare (or have prepared), submit, and receive approval of a test and inspection plan for acceptance of all structural steels in accordance with the requirements of this section before purchasing any such material. The test and inspection plan shall include provisions for submission of reports and certification to SFMTA for each shipment in accordance with the applicable requirements of Purchase Specification and specified CGHAZ impact tests.

22.5 STEEL CASTINGS

22.5.1 General

The Contractor is responsible for selecting casting grade, composition, strength, and finishing. However, steel castings used in the truck structure, bolster, and center bearing arrangement shall meet AAR Specification M-201 latest revision, Grade "B" plus 2% nickel, minimum. These castings shall be heat treated to develop a minimum tensile strength of 75,000 psi, a minimum yield strength of 48,000 psi, elongation of not less than 25% in 2 inches, and reduction of area of not less than 50%. Also, steel castings used for coupler, drawbars and anchors shall meet AAR Specification M-201, latest revision, Grade "C" quenched and tempered. Cast steel to ASTM A27, grade 65-35, may be used for truck structure, bolster and center bearing arrangements as an alternative to the AAR M-201 material specified above.

Where cast steel of superior properties is required for a specific application, the Contractor may propose such castings for SFMTA's review and approval.

22.5.2 Design Qualification of Structural Castings

One casting, selected by SFMTA from the first lot of production castings, shall be subjected to a qualification test of the casting design by the Contractor. Qualification tests shall include radiographic examination for material soundness using reference radiographs to ASTM-E446 and any mechanical testing, including static and fatigue load testing of truck frames and bolsters.

Acceptance levels for the design qualification radiographic examinations shall be selected by the Contractor as appropriate for the service intended, subject to the approval by SFMTA before any castings are produced. Radiographs shall meet the requirements of ANSI/ASTM-E94 and the quality level in the area of inspection shall be at least 2% (2-2T).

A qualification test report shall be prepared and submitted to SFMTA for approval. The production of any castings before receipt of SFMTA's approval of this report shall be at the Contractor's risk. All radiographs that resulted from the qualification test shall be made available to SFMTA for review. In case the casting selected for qualification fails to qualify, a plan of action including details of how failed material will be handled shall be included in the qualification test report. Once a design is qualified and accepted by SFMTA no changes shall be made in the casting pattern, technique, heat treatment, or material composition without re-qualification in accordance with the requirements of this section.

22.5.3 Quality of Structural Castings

All structural castings supplied shall be equal to or better than the design qualification castings in all respects. The casting supplier or Contractor shall test, inspect, and accept castings in accordance with the process described in AAR Specification M-201. In addition, the inspections below shall be performed and a written report of the results of the tests and inspections shall be furnished for each lot of castings produced.

22.5.3.1 Magnetic Particle Inspection

Magnetic particle inspections of all surfaces of each casting shall be conducted according to ASTM E709, by personnel certified to MIL-STD-410. With respect to structural castings that include coupler, bolster, articulation (where applicable), and truck castings, the maximum permissible magnetic particle indication length shall be 1/4-inch in the direction transverse to the usual direction of loading, and 3/4-inch in the direction parallel to the usual direction of loading.

22.5.3.2 Radiographic Inspection

Radiographic inspection shall be conducted according to the requirements of ASTM E94 using reference radiographs to ASTM E 446. A sampling frequency shall be proposed by the Contractor and submitted for SFMTA approval.

Structural castings shall not exceed Severity Level 3 of ASTM E446 in all critical areas of such castings and shall not exceed Level 5 in all other areas of the castings. During demonstration that the stated severity level requirements of ASTM E446 have been met, successively-produced castings shall be reinspected by radiography in the defective areas shown in the prior radiographic inspection. After such severity levels have been proved, the sampling frequency for structural castings shall be 1 casting out of each 10 produced. If no castings are rejected by radiographic inspection, this frequency may be extended to 1 casting in 25.

22.5.4 Repair Welding and Cast-Weld Design

Repair welding of castings is permitted, provided the casting supplier performs all repair welds according to the structural welding requirements of Section 22.22. Castings requiring repair or modification by welding after completion of heat treatment may be stress relieved locally by using electrically controlled heating to not greater than 1,150°F, followed by slow cooling. Manual torch stress relief shall not be permitted.

For cast-weld designs, the entire length of all assembly welds on any welded assembly of several separate castings selected for design qualification shall be radio graphically inspected to ANSI/ASTM E94 using reference radiographs from the International Institute of Welding's, "Collection of Reference Radiographs of Welds," quality level Green. Portions of assembly welds stressed in tension by service loads shall meet quality level Blue.

22.5.5 Disposal of Non-Conforming Castings

If castings are found to be non-conforming to requirements determined by the design qualification castings, the material shall be repaired, retested, and reinspected or destroyed at the Contractor's expense.

22.5.6 Steel and Aluminum Forgings

22.5.6.1 General

The Contractor is responsible for selecting forging material grade, composition, strength and finishing that will meet the intended application. Forgings that are to be welded to structure shall meet the toughness (Charpy V-notch impact) resistance specified for welded structure at the lowest operating temperature. Forgings not welded shall have adequate toughness for their intended application.

A. Steel forgings used for axles shall conform to ASTM A 729 or AAR M-101.

B. Steel forgings used for wheels shall conform to ASTM A 504, AAR M-107/208 or APTA SS-M-012-99 (revised) with residual element limits as specified in AAR M-107/208.

C. Steel forgings used for the truck structure, bolster, center-bearing arrangement or carbody structure shall be weldable and shall meet specified impact properties for welded steel structure at the lowest operating temperature.

D. Steel forgings shall comply with requirements of ASTM A 668/A 668M standard for forgings, or as proposed by the Contractor and approved by SFMTA.

E. Aluminum alloy forgings shall comply with requirements of ASTM B 247/B 247M standard, or as proposed by the Contractor and approved by SFMTA.

F. Aluminum alloy extrusions shall comply with requirements of ASTM B 221/B 221M standard, or as proposed by the Contractor and approved by SFMTA.

22.5.6.2 Design Qualification of Structural Forgings

One forging, selected by SFMTA from the first lot of production forgings, shall be subjected to a qualification test of the forging design by the Contractor. Qualification tests shall include section and etching for verification of flow pattern, magnetic particle examination for surface imperfections, and radiographic examination for internal soundness. Mechanical testing shall include static and fatigue load testing, as appropriate for the intended usage. Acceptance levels for the design qualification radiographic examinations shall be selected by the Contractor as appropriate for the service intended, subject to the approval before additional forgings are produced. Radiographs shall meet the requirements of ANSI/ASTM-E-94 and the quality level in the area of inspection shall be at least 2% (2-2T).

A qualification test report shall be prepared and submitted for approval. The production of any forgings before receipt of SFMTA's approval of this report shall be at the Contractor's risk. All radiographs that resulted from the qualification test shall be made available to SFMTA for review. In case the forging selected for qualification fails to qualify, a plan of action including details of how failed material will be handled shall be included in the qualification test report. Once a design is qualified and accepted by SFMTA no changes shall be made in the forging dies, technique, heat treatment, or material composition without re-qualification in accordance with the requirements of this section.

22.5.6.3 Quality of Structural Forgings

All forgings supplied shall be equal to or better than the design qualification forgings in all respects. The forging supplier or Contractor shall test, inspect, and accept forgings in accordance with a written process that has been reviewed and approved by SFMTA. A written report of the results of the tests and inspections shall be furnished for each lot of forgings produced.

22.6 ALUMINUM

22.6.1 General

Aluminum alloy mill products shall be identified by Unified Numbering System designations and shall conform to The Aluminum Association specifications contained in the Association's publication "Aluminum Standards and Data." Aluminum alloy castings used for door thresholds shall conform to ASTM B-26, ASTM B-85, or ASTM B-108 for, respectively, sand, die, or permanent mold castings. Aluminum alloy forgings shall conform to ASTM B-247. Copies of all test reports for sheet, extrusion, and forgings used in the car structure shall be submitted to SFMTA.

22.6.2 Design Stresses

All aluminum structural members shall be designed so that calculated stresses under the specified AW3 passenger load do not exceed the allowable stresses listed in the latest revision of the Aluminum Association of America's, "Specification for Aluminum Structures" for bridge and similar type structures and "Engineering Data for Aluminum Structures." Proper allowance shall be made for the effects of fatigue, for column and plate stability effects, and for strength reduction at welded regions. Permissible fatigue stresses under the specified AW3 passenger load shall be established, with approval based on available relevant research data or on prototype testing under the variable load patterns expected to occur in service.

22.6.3 Fabrication and Fastening

The forming of aluminum parts; joining of parts by bolting, riveting, and welding; and the protection of contact surfaces shall, as a minimum, conform to the requirements of the Aluminum Company of America's Technical Report No. 524, "Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles," except as otherwise specified herein.

Fabrication techniques shall be such that the strength and corrosion resistance of the aluminum shall not be impaired or the surface finish permanently marred or discolored during construction.

22.6.4 Protection of Contact Surface

The specific measures to be taken by the Contractor to prevent the risk of direct metal-to-metal contact and resultant possible electrolytic corrosion shall be approved and shall depend upon the determination of the most suitable method which can be adapted to the design involved. The following instructions shall be the minimum protection:

A. Aluminum alloy surfaces shall not be secured to or make direct metal-to-metal contact with the surfaces of copper, copper bearing aluminum alloy, brass, bronze, silver, nickel, nickel alloys, nickel plated parts, lead, tin, or wood.

B. The contact surfaces of aluminum alloy with aluminum alloy shall be painted with a two-part epoxy primer that is chromate-free.

C. The surfaces of aluminum alloy parts secured to steel parts shall be protected with a one-part polysulphide sealant, a corrosion-inhibiting paste or compound that is chromate-free, mica insulation joint material or an approved equivalent material that completely covers the faying surfaces. The insulating material shall be non-hygroscopic and, if fibrous, shall be impregnated with bitumen or an approved, non-corrosive, water and moisture-repellant substance. After driving, fasteners shall be primed and painted with red oxide or aluminum paint.

D. Stainless steel and carbon steel fasteners plated with zinc shall be coated with a corrosion-inhibiting paste or compound that is chromate-free before installation. Where possible, only the head and the shank of the bolt shall be in contact with the aluminum part when secured in place. Suitable bushings may be used in place of the paste or compound.

22.6.5 Interior Trim

Where unpainted aluminum is exposed to contact by passengers, it shall have a clear (natural) anodic finish. The finish process shall be the Aluminum Company of America's "Alumilite 204" with a minimum coating thickness of 0.0004 inches and a minimum coating weight of 21 milligrams per square inch, or approved equal process.

22.7 ELASTOMERS

22.7.1 General

All elastomeric parts shall be of neoprene, or approved equal, unless otherwise specified. The elastomer shall be compounded and cured to perform satisfactorily in the temperature range specified in Section 1. The elastomers shall have high resistance to ultraviolet radiation, weather, all SFMTA car washing fluids, and the longest possible life consistent with the other characteristics specified. All elastomeric parts shall be resistant to ozone, oxidation, heat, oil, grease, and acid.

The following elastomeric parts shall be of neoprene unless otherwise specified or approved:

A. Glazing Rubber
B. Door Seals
C. Door Nosing
D. Isolation Tapes/Pads
E. Other parts exposed to the outdoor ambient environment, except where otherwise specified.

All resilient mounts and elastomeric truck components shall be of natural rubber. Synthetic rubber compounds may be substituted for natural rubber only when approved for a specific application.

22.7.2 Tests

All tests shall be conducted according to the latest revisions of the specified ASTM test procedures, unless otherwise specified. All resilient, natural rubber mounts and elastomeric truck suspension components shall be tested in accordance with the procedures outlined for elastomers in Section 22.24; the results of the testing shall be submitted. The performance of only these elastomers will not be bound by the performance requirements for elastomers outlined in Section 22.24.

The test specimens shall be cut out from the extruded material, and at least one tensile strength and elongation test and one accelerated aging test shall be made on the material used for each order. If the compound or cure, or both, are changed during the production of material for one order, at least one test of each type shall be made for each different batch.

When testing the 6-inch by 1/2-inch ASTM "dumb bell" type test specimen (or smaller size if the size of the part necessitates) by the methods specified in ASTMD-3182, D-3183, D-3190, and D-412, the tensile strength shall not be less than 1,500 psi and elongation shall be a minimum 300%. The tensile strength of the elastomer shall not be reduced more than 25% when subjected

to accelerated aging by the methods specified in ASTM-D-573, for a period of 96 hours in an air oven at 70°C (158°F). The tear resistance shall be 200 minimum when tested according to ASTM-D-624. When tested according to ASTM-D-471 the ASTM #3 oil swell volume change shall not exceed 80%.

The ozone resistance of the elastomer shall be tested in accordance with ASTM D-1149 using an ozone concentration of 1 ppm, an exposure time of 100 hours at 100°F, and a specimen elongation of 20%. The elastomer shall not exhibit any cracks during the test period.

22.7.3 Life Expectancy

For all parts made by vulcanizing an elastomer to metal, any premature failure (less than 5 years) between metal and the elastomer or in the elastomer, occurring when the parts are used in normal service and according to the provisions of this Specification, shall be considered as having been caused by defect of materials or workmanship.

22.7.4 Metal Parts

Metal parts to which elastomeric material is vulcanized shall be made of SAE 1020 or SAE 1045 hot-rolled steel except for brass or brass alloys internal air brake components.

22.7.5 Bonding

The joining of elastomeric pieces shall be done by the hot vulcanization process. Bonding of elastomers shall not be allowed unless the Contractor submits the application, bonding procedure and bonding agent technical data for approval prior to the purchase of any materials.

22.7.6 Truck Parts

Truck bumpers, snubbers, and the exterior surfaces of air springs shall be made of natural rubber or approved equal. They shall be compounded to be resistant to abrasion, oil, grease, and acid.

22.7.7 Seals

Glazing strips shall be of neoprene conforming to ASTM C-542, or approved equal material.

All door mating edges, door and window seals, and glazing strips shall be of neoprene material. The durometer hardness measured with a Shore Type "A" durometer at a temperature between 70°F and 90°F shall be 70, ± 5.

22.8 GLAZING MATERIALS

22.8.1 Safety Glass

Safety glass shall meet the requirements under Item 1, Table 1 of the latest revision of ANSI Z26.1, "American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways - Safety Code."

Laminated safety glass used in the F-end of the car, including that in the end door, shall be certified as having been tested and having met the FRA 49CFR223 Type I requirements. Side window and non F-end glazing shall meet FRA 49CFR223 Type II requirements.

To prevent particles of glass from striking the Operator, the window in front of the Operator shall incorporate a spall shield as its interior surface.

22.8.1.1 Type

All safety glass shall be of the laminated sheet type and shall consist of a minimum of two sheets of glass bonded with an approved interlayer of plasticized polyvinyl butyral resin in the form of a membrane approximately 0.045-inch thick, and resistant to degradation from ultraviolet or visible light and heat.

22.8.1.2 Flatness

When an individual piece of glass is laid on a truly flat surface, such as a surface plate, the glass shall not indicate a bow of more than 0.030-inch per linear foot.

22.8.1.3 Dimension Tolerance

The overall dimensions of individual pieces as supplied shall be held within 0.060-inch of the dimensions ordered.

22.8.1.4 Overlap Tolerance

The overlap of one laminate of the piece with respect to the other, at an edge, shall not exceed 1/32-inch. Corners and burrs shall be ground smooth and all edges shall be treated in accordance with ANSI Z26.1, Section 6.

22.8.1.5 Color

The color of the glass shall be as required by Section 10. When new, there shall be no more than ± 4% variation in the color of individual pieces of laminated sheet glass when examined over a white background.

22.8.1.6 Haze

All the laminates of the safety glass shall be so nearly free from haze that the glass shall have approximately the same clarity as a piece of the same nominal thickness of plate glass when viewed against a north light.

22.8.1.7 Specks and Scratches

Occasional specks of foreign material and scratches are permissible, provided such specks do not exceed 0.020-inch in greatest dimension, a maximum of 0.75" in length, and scratches do not exceed a total sum of 3 inches in length and neither are within the central three-quarters area of the light.

22.8.1.8 Bond Separation

The bond between two sheets of glass and the membrane shall be of such quality that when the glass is broken by twisting or by direct impact, there will be no separation between the glass sheets. Lights that contain unbonded areas ("let-go's") shall not be used.

22.8.1.9 Marking

All safety glass shall be marked with proper identification in accordance with ANSI Z26.1, Section 7, and appropriate FRA-Type designation. The window light shall be installed so that the identification marking can be read from the inside lower right hand corner.

22.8.2 Plastic Glazing

Plastic glazing shall not be used.

22.9 FLOOR COVERING

Floor coverings shall meet all applicable industry standards (APTA, ADA, ASTM, FRA, etc.) as well as all safety requirements as described in Section 4 of this Specification.

22.10 WOOD AND PANELS

22.10.1 Lumber

Lumber shall be thoroughly air seasoned or kiln dried before using and shall be dressed on all surfaces to full dimensions. Lumber shall be straight-grained, free from dry rot, knots, checks, and other defects that may impair its strength and durability or mar its appearance.

22.10.2 Plymetal

The term "plymetal" as used in this Specification means metal-faced plywood. All plymetal panels shall be tested in accordance with ASTM C 273 and the following requirements. Codes and standards other than those referenced in this specification may be submitted to SFMTA for approval. The submittal shall include technical justification demonstrating that the proposed substitution meets or exceeds the Codes and standards referenced in this specification.

Mechanical Properties	Minimum Metal to Wood Average Shear Value or 80% Wood Failure
Dry shear	250 lbf/in^2
Boil shear; 3-hour boil; tested wet at room temperature	150 lbf/in^2
Soak shear; 48-hour soak wet at room temperature	150 lbf/in^2
Creep or cold flow; under static load for 48 hours; at room temperature	250 lbf/in^2

The metal face of the plymetal panel that is faced with melamine shall be constructed in accordance with Section 22.10.6 prior to the melamine-faced metal panel being laminated to the plywood core.

22.10.3 Plywood

All plywood shall be manufactured to conform with the requirements of Grade - Structural I of the National Bureau of Standards Voluntary Product Standard (American Plywood Association) PS 1-95, or approved equal and then stored under cover. Each plywood panel shall be formed from one piece. Scarf or finger jointed panels are not allowed. All plywood shall be sealed with two coats of an epoxy paint, or approved equal on all edges and cutouts as soon as possible after fabrication. All exposed edges of the panels, joints between panels, fastener heads, and openings of panels used in areas accessible to moisture shall be waterproofed and sealed with an approved coating prior to installation in the car.

22.10.4 Honeycomb Panels

The term "honeycomb panels" as used in this Specification refers to an assembly of honeycomb material bonded to melamine-faced metal panels or to metal panels. Honeycomb material shall be commercial-grade 3003 aluminum honeycomb meeting the requirements of MIL-C-7438G. Bonding shall be sufficient to develop the full strength of the honeycomb material.

22.10.5 Panel Contour Tolerance

Surfaces exposed to passengers shall not deviate from the specified contour by more than 3/32-inch in any 36-inch distance. The slope of any such deviation shall not exceed 3/32-inch in 12 inches.

22.10.6 Melamine-Faced Aluminum

Melamine-faced aluminum panels shall be constructed by laminating melamine to aluminum sheets. The melamine-impregnated papers shall be directly molded to the aluminum sheets at temperatures of no less than 270°F and pressure no less than 1,000 psi. The surface characteristics, after manufacture, shall be no less than that required of type GP (General Purpose) in the NEMA Standards Publication No. LD-3, latest revision. The melamine and the required binder sheets shall be 0.013 inches, ± 0.005-inch thick. The aluminum sheets shall not be less than 0.025-inch in thickness when used as a facing on plywood. The aluminum sheets shall not be less than 0.081-inch in thickness when not laminated to a substrate such as plywood. Aluminum sheets shall be properly cleaned by etching, sanding, or other approved process to ensure full, permanent, adhesion.

The use of contact adhesives to bond the melamine sheets to the aluminum backing is not acceptable.

The bond between the melamine and aluminum sheets shall, as a minimum, meet the following requirements:

A. Internal bond (ASTM-D-952): 2,600 lbf/in^2

B. Flexural strength - (S) (ASTM-D-790)

   1. With grain: 26,500 lbf/in^2
   2. Crossgrain: 25,300 lbf/in^2

C. Modulus of elasticity - (E) (ASTM-D-790)

   1. With grain: 2.8×10^6 lbf/in^2
   2. Crossgrain: 3.1×10^6 lbf/in^2

D. Tensile strength (ASTM-D-638)

   1. With grain: 22,300 lbf/in^2
   2. Crossgrain: 20,300 lbf/in^2

22.10.7 Phenolic Cored Panels for Flooring

Phenolic cored panels shall mean panels constructed of top and bottom fiberglass-reinforced phenolic resin matrix skins encapsulating a phenolic reinforced, syntactic foam coring. The panel skins shall be comprised, at a minimum, of 24 oz/square yard bi-axial and 9 oz/square yard mat laminated on each side of reinforced, syntactic foam coring. The corresponding minimum skin thicknesses shall be 0.050 inches thick.

The thickness of the phenolic resin matrix skins shall be increased, if necessary, to meet the following strength requirements. With the vehicle floor loaded to simulate a uniformly-distributed AW3 passenger load plus interior equipment, such as seats, interior liners, and equipment boxes, the following conditions shall be met:

A. The floor panels shall not deflect more than 1/250 of the shortest span between supports, up to a maximum of 1/16 of an inch. The floor shall not take a permanent set when the load is removed. An analysis shall be submitted demonstrating compliance to deflection requirements.

B. The floor panels shall sustain no permanent deformation under normal use (passenger portion of AW3 distributed uniformly along the vehicle during the design life of the car, and shall be designed to withstand the specified loading without exceeding 50 percent of the yield stress of the flooring material.

C. The maximum stress in the floor beams shall be less than 50 percent of the critical buckling stress or 50 percent of the yield strength of the material, whichever is less.

The panel structure shall contain a dense fiberglass reinforced phenolic resin close-out core to provide support for all edges, cut outs and holes. Fastener holes shall be pre-drilled and countersunk to accommodate the approved fasteners.

The panel shall be manufactured using the matched die molding process with the application of heat and pressure. Production techniques shall ensure that the glass fiber reinforcement is

uniformly distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections.

A stress analysis shall be performed to confirm that the construction of the manufactured panel is adequate for its intended purpose and meets the specified strength requirements.

The panel shall meet the following requirements:

Mechanical Properties	ASTM Test	Requirement
Flatwise Tension	C-297	Strength greater than 1,300 psi
Flatwise Compression	C-365	Strength greater than 1,210 psi
Flatwise Shear	C-273	Strength greater than 310 psi
Flexural Properties	C-393	For a span of 15 inches, failure load greater than 155 lb/in

22.11 SECTION DELETED

22.12 FIBERGLASS-REINFORCED PLASTIC

22.12.1 General

Fiberglass-reinforced plastic (FRP) shall be a glass-fiber-reinforced, laminated material, composed of a gel coated surface, fiberglass reinforcement, and an approved resin. FRP shall withstand, without any physical deformation or structural damage, the environmental conditions in Section 1, be resistant to acids, alkalies, and cleaning solutions recommended by the Contractor.

FRP shall be manufactured by either open molding, hand layup, or the matched die molding process. Production techniques shall ensure that the glass fiber reinforcement is distributed throughout the final product in such a manner as to avoid resin-rich or resin-starved sections.

FRP parts shall have a greater thickness at attachment points and edges. Exposed sharp edges will not be allowed on any parts. A stress analysis shall be performed to confirm that the construction method chosen is adequate for its intended purpose and meets the specified strength requirements.

22.12.2 Construction

22.12.2.1 Resin

The resin shall be of good commercial grade, thermosetting, material selected to meet the physical properties of this Specification and molding process requirements.

22.12.2.2 Reinforcement

The fiberglass reinforcement shall be mat, fabric, woven roving, continuous roving, chopped spun roving, or swirl mat as required to meet the physical properties of this Specification and

the molding process requirements. The glass content shall be a confirmed through testing to ASTM-D-2584.

22.12.2.3 Gel Coat

The gel coat shall be resistant to scuffing, fire, weather, and cleaning agents. The gel coat shall have a minimum thickness of 0.016 inches and a maximum thickness of 0.032 inches. If the surface of the FRP panel is to be painted, a primer gel coat shall be used and the part shall be painted in accordance with Section 22.23. If the FRP panel does not receive paint, then the gel coat shall be pigmented to match the color selected by SFMTA. Three sets of samples shall be submitted to SFMTA.

Finished gel coated surfaces shall have a minimum gloss value of 85 when measured with a 60^0glossometer and shall exhibit no print through of the reinforcements or have any appreciable orange peel.

22.12.2.4 Additives

Additives, fillers, monomers, catalysts, activators, pigments, fire retardants, and smoke inhibitors shall be added to the resin mixes to obtain finished products with the required physical characteristics of this Specification.

Mineral filler shall not exceed 28% of finished weight for any preformed matched die molding process.

22.12.3 Strength Requirements

Independent laboratory tests shall be performed on test coupons that are trimmed from production parts. Independent laboratory test reports shall be provided confirming that the reinforced plastic material complies with the requirements of the following standards.Test specimens shall be conditioned in accordance with ASTM D 618.

Minimum Requirements – Interior Components

Mechanical Properties	ASTM Test	Open or Match Die Moldings
Tensile Strength	D-638	10,000 lbf/in^2
Compressive Strength	D-695	18,000 lbf/in^2
Flexural Strength	D-790	15,000 lbf/in^2
Impact Strength	D-256	6 ft.-lbs per inch of notch
Hardness	–	45 Barcol

Minimum Requirements – Exterior Components

Mechanical Properties	ASTM Test	Open or Match Die Molding
Tensile Strength	D-638	18,000 lbf/in^2
Compressive Strength	D-695	24,000 lbf/in^2
Flexural Strength	D-790	30,000 lbf/in^2
Impact Strength	D-256	8 ft.-lbs per inch of notch
Hardness	–	45 Barcol

22.13 THERMOPLASTIC SHEET

22.13.1 General

Thermoplastic sheet used in the construction of this vehicle shall withstand, without any physical deformation or structural damage, the environmental conditions described in Section 1 and shall be resistant to SFMTA cleaning solutions. Thermoplastic sheet shall be used as extruded or vacuum-formed.

Thermoplastic sheet shall be homogeneous and extruded from virgin stock which does not include any regrind of vacuum formed parts. The exposed surface of this material shall conform to the color, texture, and gloss specified in 22.8. Only UV stabilized pigments shall be used to create the specified color of the thermoplastic sheet. The color and surface finish of parts manufactured from this material shall be approved prior to the production run of any parts. Three sets of samples shall be submitted to SFMTA.

22.13.2 Quality

The finished parts shall be free of waves and quilting on both sides. Degraded polymer in the sheet shall not be allowed, and if present, shall be cause for rejection of the piece. Voids, lumps, and contamination shall also be cause for rejection of parts if the defects are larger than 0.010-inch, and the population of these defects is greater than one defect in four square feet.

22.13.3 Strength Requirements

Independent laboratory test certificates shall be provided stating that the thermoplastic sheet complies with the requirements of the following standards. Extruded sheet in the surface finish specified shall be used for testing.

Mechanical Properties	ASTM Method	Value
Specific Gravity	D-792	1.20 to 1.45
Tensile Strength	D-638	5,500 lbf/in^2 minimum
Flexural Strength	D-790	8,000 lbf/in^2 minimum
Flexural Modulus	D-790	3.3×10^5 lbf/in^2
Hardness Rockwell "R" Scale	D-785	90 to 110
Heat Shrinkage; 15 minutes at 350°F	–	10% maximum
Heat Deflection (annealed) at 264 lbf/in^2	D-648	165°F minimum
Impact Strength, Fabricated Parts; Gardener Dart Drop 1/2-inch diameter ball at 73°F	D5420: 1996 and D5628	160 in-lb. Minimum

22.14 PIPING AND TUBING

22.14.1 General

All piping, valves, fittings, installation methods, and testing shall be in accordance with the Code for Pressure Piping, ANSI B31.1. All joints shall be easily accessible. All cut-out cocks or other manually operated valves shall be locking type with provisions for safety wire.

Following installation, all piping systems shall be cleaned to remove dirt, metal chips, oily contamination, and moisture. After cleaning, all piping systems shall be pressure tested in accordance with the latest edition of the Code for Pressure Piping, ANSI B31.1. All leaks shall be repaired and the system recleaned and retested until leak-free.

Pipes must be supported throughout their length and at all connections to prevent vibration or noise and to limit stresses in the pipe to less than 50% of the pipe's fatigue endurance limit. Pipes and their connections shall not interfere with the removal of other components. Pipe routing and support shall be planned and accomplished in an efficient, organized manner to keep the total length and number of fittings and bends to an absolute minimum. All changes in direction shall be accomplished by bending the pipe to a radius of not less than specified by AAR Specification No. 2518, Standard S-400, and not with fittings. Support and clearances provided between adjacent pipes and between pipes and surrounding structure, equipment or other appurtenances shall be sufficient to prevent chafing or contact due to any combination of car loading and deflection, car dynamics, and thermally induced movement. The minimum clearance shall be 1/4-inch.

At all locations where pipe or tubing passes through holes in the floor, bulkheads, structure, or any fixed member, it shall be rigidly clamped to protect against possible damage or noise due to bearing, abrasion, or car dynamics-induced rattling. Clamps shall not be welded, brazed or otherwise permanently fastened to any pipe or tubing. Pipe and tubing interfaces with clamps shall be insulated with an elastomeric or woven non-asbestos mineral fabric tape material to protect and sound-insulate the pipe or tubing.

Wherever carbody piping interfaces with vibration-isolated rotating equipment such as the air compressor and air conditioning compressor-condenser unit, approved flexible vibration eliminators shall be used. The pipe connection at either end of the flexible elements shall be rigidly clamped no farther than 2 inches from the flexible elements. All pipe clamps shall be inherently rigid and shall be firmly attached to car structure. Cantilevered clamps or clamp supports that are weaker than service-proven designs will not be accepted. All clamps shall be of a suitable material for the application.

22.14.2 Air Piping, Tubing and Fittings

All pneumatic piping shall conform to ASTM A269, 304L seamless annealed stainless steel tubing, 18 gage minimum wall for ½-inch tubing, 16 gage minimum for 3/4-inch tubing, 14 gage for 7/8-inch tubing. All air pipes shall be sized in accordance with the function intended. The diameter of the main reservoir pipe and brake pipes shall meet the brake supplier's requirements; however, in no case shall these pipes be less than 7/8-inch O.D.

All air piping must comply in all respects with the air brake supplier's design and installation requirements. Prior to manufacture of production cars, the Contractor shall provide SFMTA with a report containing written approval from the air brake supplier of the Contractor's air brake piping fabrication, installation, and design concept. The following information shall be contained in the report:

A. All critical line sizes and materials including the main reservoir pipe, the emergency brake pipe, and the brake cylinder piping.

B. The installation details of the above critical lines including routing, total length and volume, elevation and slopes, and major joint and direction change locations. A list of all proposed bend radii shall also be provided.

C. Pipe processing details including welding, brazing, cleaning, and fabrication methods, as required by Section 22.22.

D. Locations of all major air brake control, relay, and emergency venting devices, and the proposed location and volume of all reservoirs.

E. An air consumption analysis justifying the proposed air storage system design.

All air piping shall be installed in a manner to provide drainage away from devices, or branch pipes leading to devices, when the function of those devices could be impaired by the accumulation of water or ice. Low spots (traps) are strictly prohibited on the trucks. Truck piping shall not be run on the bottom of truck side frames, transom or bolster. All connections and joints where disassembly for service may be required shall utilize hydraulic piping-style, bevel seal fittings with threaded retaining nuts. The use of threaded fittings, where the threaded connection is used to retain piping pressure integrity, is expressly prohibited.

All pneumatic piping shall be retained by clamping devices with rubber inserts. All clamps shall have a minimum of two fasteners. Single fastener clamps, e.g. P-clamps, are expressly prohibited.

All hose and hose fittings utilized within the air system shall be in compliance with AAR M-601, AAR M-618, AAR M-620 and AAR M-927. All hose fittings shall be of the reusable type as manufactured by Stratoflex, or approved equal.

All cut-out cocks shall be of the vented type, except where function prohibits. All cut-out cock handles and their arrangements shall be as described in the Friction Brake section of this Specification.

22.14.3 Section Deleted

22.14.4 Brazing and Soldering of Piping, Tubing and Fittings

All brazing and soldering shall comply with the applicable parts of Section 22.22, and the following requirements. Unless specifically approved, all refrigerant piping and air system copper tubing shall be joined using silver solder conforming to Federal Specification QQ-B-654, Class 1 or 3. Refrigeration piping and tubing shall be internally swept with a continuous flow of a non-oxidizing gas such as dry nitrogen during brazing. Condensate drain tubing shall be joined using 95-5 solder or Silver Solder as above. Solder joints shall be wiped and have flux cleaned from tubing and fittings after soldering. After fabrication, the refrigeration and air systems shall each be cleared of all dirt and foreign matter, flushed with a degreasing agent and dried, all according to a written procedure prepared for each by the Contractor and approved by SFMTA.

22.14.5 Hydraulic Piping, Tubing and Fittings

All hydraulic pipes, tubing, and fittings shall be sized for the function intended without experiencing a pressure drop of more than 15% from control to function. All exposed tubing, piping, or fittings shall be stainless steel to MIL-T-6845 or MIL-T-8504 specifications. Tubing, piping, or fittings protected from under car exposure may be either stainless steel or carbon steel to SAE J524, SAE J535, or SAE J356 standards. Wall thickness shall be Schedule 80 for

truck-mounted piping and sufficient to maintain a safety factor of 6 at the maximum system pressure. Wall thickness in other locations shall be sufficient to maintain a safety factor of 6 at the maximum system pressure.

All joints for tubing or piping shall utilize fittings of the same material as the tubing or piping. Joints shall be welded, brazed, flared to 37-degrees in accordance with SAE J533b, or made with compression fittings, Swage-Lock, or equal. Connections to manifold ports, valve bodies, and other hydraulic system components shall use straight thread fittings with separate O-ring seals. Quick connect couplings shall be of the double shutoff type with valves built into both mating parts of the coupling.

All hose utilized within the hydraulic system shall conform to SAE J517 standard and hose fittings shall conform to SAE J516 standard. All hose shall be rated to withstand four times the maximum operating pressure without bursting. Hose application limits shall conform to SAE J1273, SAE J343, and SAE J1405 standards. Hose shall not be used in locations where the temperature may exceed 200^{o}F. Hose shall be supplied clean and with both ends capped.

There shall be no inaccessible joints. Tubing shall be bent utilizing a bending tool designed specifically for bending of the tubing to be used. All tubing and piping shall be deburred after cutting. Bent tubing shall have a uniform bend free of kinks. All tubing, fittings, and subassemblies shall be cleaned and capped on all openings after fabrication. Caps shall remain in place until immediately prior to incorporation into the final assembly.

Truck piping shall not be run on the bottom of truck sides, frames, transom, or bolster.

All cut-out cocks shall be designed to automatically depressurize the portion of the system which is being isolated by the cut-out cock.

22.15 SECTION DELETED

22.16 WIRE AND CABLE

22.16.1 General

A minimum number of wire types and sizes shall be used in the vehicle.

Selection of wire sizes and insulations shall be based on the current carrying capacity, voltage drop, mechanical strength, temperature, and flexibility requirements in accordance with applicable AAR, ICEA, ASTM, NEC, and MIL Specifications. However, in no case shall the properties of the wire and cable be less than those properties delineated in this Specification. Extra-fine wire stranding shall be utilized on applications subject to repetitive motion.

All applications of shielded cable shall be approved.

The Contractor and each supplier of equipment shall, through the Contractor, submit samples (at least 12 inches long), specifications, and qualification test documentation of each size and type of wire and cable specified, for approval, before utilizing said wire and cable.

Three copies of notarized, certified test reports shall be furnished by the Contractor.

Only wire or cable shall be used for carrying electrical current. Exceptions are third rail shoes and other devices specifically designed to be electrical conductors. Where this Specification uses wire insulation trade names, the use of an approved equal is acceptable.

Cable and wire shall be installed such that clearance is provided between any part of the carbody or support brackets. At no time shall the clearance between the cable or wire and carbody or brackets or wire trays be less than 1/4-inch.

Cables shall not be closer than 2 inches to any wheel or other moving surface.

22.16.2 Conductors

Conductors shall be soft, annealed tinned copper, in accordance with ASTM B 33 unless otherwise noted. Minimum stranding shall conform to AAR Standard RP-585 (S501), RP-589 (S502) or ASTM B 172 Class K or ICEA S-66-524, Table L-7, Class K for AWG No. 10 or larger, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 12 to AWG No. 16 shall be in accordance with ASTM B 174 Class K or ICEA S-66-524, Table L-8, Class M, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 18 and smaller shall be in accordance with ASTM B 174 Class L or ICEA S-19-81, Table L-8, Class M, or shall be 19 strand construction as appropriate for the wire size.

The use of solid wire is not permitted except for approved wire wrap applications.

Wiring shall be sized for the intended load, voltage drop, installation method, and applicable codes. Maximum wire ampacities shall conform to the National Electric Code (NFPA 70) Table 310-16, 110°C column for wires in raceways or conduit, and Table 310-17, 110°C column for wires in free air. When the free air rating is used, the Contractor shall furnish data to show that the cables will not exceed their rated temperature at the rated current. Where more than three conductors are routed in a raceway or conduit, the ampacities shall be derated as detailed by Note 8 to Tables 310-16 through 310-19. Wire ampacities shall be derated to meet the temperature requirements of all devices to which the wire connects. When short time ratings, short time overload temperatures, and thermal time constants are used to determine cable size, the parameters used will be submitted for approval.

In no case shall wire smaller than the following sizes be used:

A. Wire that is pulled through conduits or wireways - No. 16 AWG.
B. Wire on electronic units, cards, and card racks - No. 28 AWG.
C. Wire within control compartments - No. 18 AWG.
D. Multi-conductor cables where current is not a factor in wire size selection, such as LED indicator lights or status displays - No. 18 AWG.
E. All other wire, including that which is laid in, rather than pulled through, wireways - No. 16 AWG.
F. Multi-conductor cables within control compartments – AWG No. 20.

Trainline wiring, and all associated connections, shall be sized for operation of consists with the maximum number of cars as allowed by Section 1. The maximum voltage drop permitted between the battery or LVPS and any load in the vehicle shall not be greater than 2 V. Voltage drop measurements shall include both the supply and return leads as well as intervening circuit breakers and switches.

22.16.3 Insulation

22.16.3.1 General Wiring Insulation

The insulation shall be rated at 2,000 VDC in the case of wires carrying a nominal voltage greater than 100 VAC or VDC, and rated at 600 VDC in the case of wires carrying a nominal voltage equal to 100 V or less, AC or DC.

For all general carbody wiring, the insulation shall be a flame retardant, flexible, cross-linked polyolefin material having a continuous temperature rating of 110°C. Cables for data transmission, where cable current is not a factor for the selection of the cable cross section, may be rated for a lower temperature as proposed by the Contractor and approved by SFMTA. For wire sizes No.6 AWG and larger, the insulation material shall be formulated for extra flexibility. The use of thin-wall irradiated cross-linked polyolefin insulated wire will be considered on a case by case basis provided it can meet the requirements delineated below.

The irradiated cross-linked polyolefin wire insulation shall be constructed and tested in accordance with the requirements of AAR RP-585 and the following additional special requirements:

A. The smoke, flammability, and toxicity requirements follow:

   1. Flammability test shall be performed in accordance with AAR RP-585 except that the duration of burning of the specimen after the fifth and last application of the flame shall not exceed 3 seconds.

   2. Smoke Density (Test Method, ASTM E 662: When tested in a National Bureau of Standards Smoke Chamber in accordance with the procedure specified in Section 8.5.3.1, the Specific Optical Density (Ds) at 4 minutes shall not exceed:

      a. On a flaming test: 200
      b. On a non-flaming test: 75

   3. Toxicity: See 5.2 for requirements.

B. The insulation shall be in accordance with the requirements of AAR Standard S-501 and the additional special industry requirements in the following list:

   1. Insulation Resistance (Test Method ASTM Standard D 470): The minimum value shall be 1000 megohms for 1000 feet, using a 1000Vdc megohmmeter..

   2. Heat Distortion – (Test Method per ICEA S-95-658) (150^{o}C ±2^{o}C, maximum percent of unaged value):

a. No. 4/0 AWG and smaller: 20%
b. Larger than No. 4/0: 10%

3. Moisture Absorption – Gravimetric Method (ASTM Standard D 470); (70°C, ±2°C, for 168 hours):

   a. Maximum absorption in milligrams per square inch: 8

4. Moisture Absorption - Electrical Method (ICEA S-66-524): Increase in Capacitance, Maximum Percent:

   a. 1 - 14 Days: 3.0%

   b. 7 - 14 Days: 1.5%

   c. Stability Factor after 14 Days: 1.0%

   d. Alternate to Stability Factor Stability Factor Difference, 1 -14 Days Maximum: 0.5%

   e. Specific Inductive Capacity (1 Day Maximum): 6.0%

5. Ozone (Test Method per ICEA S-10-81 paragraph 6.8): After 24 hours exposure to an ozone concentration of 0.03% by volume at 90°C, ±2°C, there shall be no insulation cracks.

6. Tension Set (Test Method per ICEA S-19-81 paragraph 6.4.15.4 or ICEA S-66-524 paragraph 6.4.11.4); (Except that the specimen shall be stretched until the 2 inch gauge marks are 4 inches apart.): Maximum: 30%

7. Corrosion (Test Method ASTM Standard D 2671-Copper Mirror): The test specimen shall be approximately 0.4 gram of the insulation, cut into small pieces. After a test period of 2 hours at 175° ± 2°C, the removal of more than 5% of the copper film constitutes a failure. Duplicate test (two separate mirrors) shall be run. Specimen must pass both tests.

8. Abrasion Resistance (Test Method AAR RP 585): Abrasion resistance test shall be performed in accordance with Section 5.9.6 except that the finished cable shall show a resistance of no less than 5000 strokes.

9. Insulated cable, 1 AWG or larger shall be tested to the IEEE standard 383 (70,000 BTU/HR flame. Propagation maximum shall be 36 inches (914 mm) above flame source and there shall be no propagation after 15 minutes of the 20 minute test.

10. Notch Propagation: Notch samples around the whole wire and cable circumference to the depth shown in table below. Place notch so that it touches and is parallel with the axis of the mandrel. Wrap the notched cable around the mandrel for 3 complete turns on each side of the notch. Place the wrapped samples (on mandrel) in the environmental temperature chamber and soak for 4 hours at -13°F ± 9°F (-25°C ± 5°C). After each temperature soak, the sample

shall be returned to room temperature and then subjected to the voltage Test No. 3.1 on Table 3.1 of ICEA Specification S-66-524, Column A. (NEMA WC70).

Size of Conductor	Diameter of Mandrel	Depth of Notch (Mils)
18 through No. 10	3 x cable diameter	10/15
8 through 1		15/18
1/0 through 4/0		22
250 and larger		35

Exposure of the conductor or failure to pass the voltage tests of any of the three specimens will constitute a failure.

11. Single Conductor Thermal Overload Test: A continuous current of 115 amperes shall be applied to an 18 foot (5.5 m) length of AWG No. 10 test wire in 77°F (25°C) still air. A 3000 volt dc potential shall be maintained between the test wire and an AWG No. 18 bare copper wire wrapped snugly around the outer insulation surface of the test wire. Failure shall be defined to occur when a short circuit is established between the bare copper wire and the test wire. Minimum time to failure shall be three (3) minutes.

12. Bundle Overload: A bundle overload using a seven-wire bundle shall be performed in accordance with AAR Standard RP-585 (S501), paragraph 5.9.1, and test results recorded.

13. Temperature Cycling Tests: This test shall be done on an 8 ft. (2.4 m) length sample of AWG No. 10 wire with 2 kV insulation.

    a. Thermocouples shall be attached to the outer jacket surface, and on the conductor, under a small incision in the insulation about 12 inches (305 mm) from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.

    b. Prior to temperature cycling, the sample shall be conditioned for 2 hours at a temperature of 302°F (150°C).

    c. The sample shall then be temperature cycled between ambients of 257°F (125°C) and -22°F (-30°C) by transferring the sample between an air-circulating oven, set at 257°F (125°C) and an air-circulating cold box set at -22°F (-30°C). The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.

    d. One cycle shall be defined as an approved dwell time at both 257°F (125°C) and -22°F (-30°C). The sample shall be subjected to a total of 250 cycles, with a visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of

5 kVAC for 5 minutes and also examined by microscope to verify that no cracks exist.

C. Flame-retardant, flexible, irradiated cross-linked polyolefin insulation rated at 257°F (125°C) may be used, provided it meets all the above standards, modified to reflect the temperature rating related characteristics. The revised values, and the use of such wire, must be approved. Cross-linked polyolefin insulation is not permitted for use on wires connected to heater elements or any other high-temperature device.

D. All insulation other than irradiated cross-linked polyolefin shall meet the following test requirements based on MIL-W-22759 and using the following parameters:

1. Dielectric: Test per MIL-W-22759/10B (for 1,000 V wire with tests at 9.5 KV impulse) or MIL-W-22759/6B (for 600 V wires with tests at 8 KV impulse).

2. Insulation Resistance: Test per ASTM D 470. Minimum accepted value shall be 1,000 megohms per 1,000 feet (304.8 m), using a 1,000 VDC megohmmeter.

3. Spark Test. One hundred percent of all single conductor cables and all single conductor cables being used in a multi-conductor cable shall be inspected by Impulse Dielectric Test or by chain electrode Spark Test. Spark Test Apparatus and Procedure shall be in accordance with MIL-W-22759. Spark Test voltages shall be equivalent to impulse test voltages by corresponding RMS value at 3 kilohertz.

Impulse Test Voltage KV Peak	3 KHz Test Voltage KV RMS
8	5.7
9.5	6.7
10	7.1

4. Air Aging: Test per ASTM D 638. Age sample for seven days at 302°F (150°C) in an air oven. Minimum tensile strength and elongation shall not be less than 85 percent of the unaged values. Also test per IEEE Standard 383-1974 and ASTM D 573 for extended life.

5. Cold Bend: Test per NEMA WC3, except test temperature shall be -58°F (-50°C).

6. Weight Loss: Weight loss of the insulation material shall not exceed one percent when subjected to an oven temperature of 266°F (130°C) for 500 hours.

7. Chemical Resistance: An appropriate length of sample shall be measured for insulation diameter and total weight to record initial values. The wire shall be immersed to within 3 inches (76.2 mm) of each end in the test fluid for 24 hours at 149°F (65°C). During the immersion stage, the minimum bend radius of the wire shall be 10 times the diameter of the wire being tested. Upon removal from the test fluid, the specimen shall be cooled to room temperature for one hour and the diameter gauged and reweighed for comparison with the original values. The maximum diameter and weight increase shall not exceed 30 percent. Typical fluids for this test include:

    a. Humble No. 1014 Railroad Diesel Lubricating Oil and lubricants (100 percent solution)

    b. Humble Diesel 260 or Railroad T fuel oil (100 percent solution)

    c. Mineral oil (100 percent solution)

    d. Hydrochloric acid, nitric acid, sodium hydroxide, sulfuric acid (0.1 percent solution)

    e. Potassium hydroxide (0.1 percent solution)

    f. Petroleum distillates and other graffiti removers and cleaning compounds used at SFMTA

    g. Kerosene solvents (100 percent solution)

    h. Trisodium phosphate solution (50 percent solution)

    i. Skydrol 500 B hydraulic fluid (100 percent solution)

    j. Water.

8. Temperature Cycling Testing: The test shall be done on an 8 foot (2439 mm) length sample of AWG No. 12.

    a. Thermocouples shall be attached to the outer jacket surface, and on the conductor under a small incision in the insulation about 12 inches (305 mm) from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.

    b. The sample shall be conditioned for 2 hours at a temperature of 302°F (150°C). The sample shall then be temperature cycled between ambients of 257°F (125°C) and -22°F (-30°C) by transferring the sample between an air-circulating oven, set at 257°F (125°C) and an air-circulating cold box set at -22°F (-30°C). The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.

c. One cycle shall be defined as an approved dwell time at both 257°F (125°C) and -22°F (-30°C). The sample shall be subjected to a total of 250 cycles, with visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of 5 kVAC for 5 minutes and also examined by microscope to verify that no cracks exist.

9. Single Conductor Thermal Overload Test: A continuous current of 115 amperes shall be applied to an 18 inch (45 mm) length of AWG No. 12 test wire in 77°F (25°C) still air. A 1,000-volt dc potential shall be maintained between the test wire and an AWG No. 18 bare copper wire wrapped snugly around the outer insulating surface of the test wire. Failure shall be defined to occur when a short circuit is established between the copper wire and the test wire. Minimum time to failure shall be three minutes.

10. Seven-Wire Bundle Thermal Overload Test: A seven-wire cable bundle shall be formed by twisting six insulated AWG No. 12 conductors around a center insulated AWG No. 12 conductor.

    A 120 ampere current shall be passed through the center conductor for seven minutes. After a test period the cable bundle shall be examined for visible damage to the outer six conductors. Failure shall be defined to occur if any of the outer conductors split, rupture or melt and adhere to the center conductor insulation.

11. Qualification and Production Tests: The tests required for this Specification concerning Qualification and Production shall be in accordance with tests required in MIL-W-22759 for all lots produced, as called for in this Specification.

    All test reports covering Production and Qualification tests shall be furnished with requested samples prior to any shipment of materials.

22.16.3.2 Wire Insulation for High Temperature Applications

High temperature insulation shall be used where connected to heat-generating apparatus, where the ambient temperature can exceed 257°F (125°C), or where Teflon is specified as a requirement. The insulation shall be rated at 1,000 volts DC in the case of wires carrying a nominal voltage greater than 100 volts AC or DC, and rated at 600 volts DC in the case of wires carrying a nominal voltage equal to or less than 100 volts AC or DC. The insulation shall have a continuous temperature rating of 302°F (150°C) or above and be in accordance with the following requirements:

A. For wire sizes No. 16 AWG and larger: abrasion-resistant Teflon Polytetra-fluoroethylene (PTFE) meeting MIL-W-22759/6B or 10B as appropriate for voltage used, or silicone rubber meeting AAR S-503.

B. For wire sizes No. 18 AWG and smaller: abrasion-resistant PTFE Teflon meeting MIL-W-22759/6B or 10B as appropriate. When used for interconnecting pieces of

apparatus, this type wire shall be in bundles with a protective covering of high temperature, low smoke generating insulation.

The Contractor may propose other insulated wire specifications for approval in a specific high temperature application, specifying the design ambient temperature, routing, RMS ampere value, worst-case ampere value, worst-case temperature rise, stranding, and insulation material specification.

No high temperature insulated wire shall be used in conduit or raceways without specific approval. The Contractor shall submit all applications of high temperature wire insulation for approval.

22.16.3.3 Wire Insulation Within Equipment

Insulation on wiring within replaceable modular units, electronic apparatus such as cards and card racks, and other equipment, as approved, shall be Tefzel Ethylenetetrafluoroethylene (ETFE) per ASTM D 3159 and insulation construction per Military Specification MIL-W-22759/16 (AS), irradiated cross-linked polyolefin per Section 22.16.3.1 above, or Teflon Polytetrafluorethylene (PTFE) type EE per Military Specification MIL-W-16878/5.

22.16.3.4 Wire Insulation at Crowded Locations

Wire for connections to the control console, or in any other locations where there are equally crowded concentrations of low voltage control wiring, shall be insulated with Tefzel (ETFE) per ASTM D 3159 and insulation construction per Military Specification MIL-W-22759/16 (AS) except the wall thickness shall be 0.025 inches. When used for this application, these type wires shall be bundled with a protective covering of cross-linked modified polyolefin or similar approved high temperature rated, low smoke generating insulation.

22.16.4 Multi-Conductor Cables

22.16.4.1 General

Multi-conductor cables, where approved, shall be constructed using wiring as described in Section 22.16.2 and 22.16.3 and/or NEMA WC27500. Where a conflict exists, the most restrictive condition will apply. Multi-conductor cables shall be made by assembling individual or twisted pairs of stranded wires in a cylindrical form using non-hygroscopic, flame and smoke resistant fibers and tape meeting the requirements of this Specification. For high temperature applications, the cable shall conform to MIL-C-27072, with Type V connectors, Style 4 sheaths, Class D jackets, if needed, and shields, if needed. All conductors in multi-conductor cables shall be color coded or otherwise permanently identified as approved. Materials used in the construction of multi-conductor cables shall meet the requirements below. In applications where current is not a factor in wire size selection, such as LED indicator lights or status displays, AWG No. 16 may be used between repeater devices and displays. If approved, flat ribbon cable may be used for internal wiring applications to equipment enclosures and electronic racks to interconnect different printed circuit boards.

22.16.4.2 Fillers

Where required to obtain a circular cross-section, fillers shall be made of non-hygroscopic materials compatible with the wire insulation and jacket, and shall be of the same or of a higher temperature rating than the wire insulation.

22.16.4.3 Tape

A binder tape shall be employed over the assembly of conductors in multi-conductor cables if needed to assist in cable manufacture, or as required to permit the cable to function as intended in its application. The binder tape material shall be non-hygroscopic and shall be of the same (or better) temperature class as the wire insulation, and shall be of a compatible material.

22.16.4.4 Shield

The shield, if required, shall consist of either copper braid, concentrically served copper, or aluminum/polyester tape with a drain wire, as is appropriate for the application. The shields shall have the following minimum properties:

A. Copper shield shall be made of either tinned, coated copper strands which conform to ASTM-B-33, or silver-coated copper strands which conform to ASTM-B-298, as is appropriate for the wire insulation. Shield coverage shall not be less than 85%. Shield strand size and application shall be as recommended by the cable manufacturer for the particular application but shall not be smaller than AWG No. 38..

B. Aluminum/polyester tape shields shall consist of a helical wrap of aluminum/ polyester tape with a nominal thickness of 0.0004 inch aluminum on a backing of 0.001-inch polyester. The tape shall have a minimum overlap of 10% of the tape width to ensure complete coverage. In contact with the aluminum side of the shielding tape shall be a No. 22 AWG 7/30 tinned copper drain wire conforming to ASTM-B-33 and B-174.

22.16.4.5 Jackets

The overall jacket of multi-conductor cables shall be of flame retardant, cross-linked, modified polyolefin; ETFE Tefzel or PTFE Teflon to match the wire insulation and application as approved. The coupler cable shall have a jacket of low temperature arctic grade neoprene per MIL-C-13777, with a wall thickness suitable for 600 volts. The jacket shall be extruded and vulcanized over the cabled conductors, and shall be well centered, with a smooth appearance without objectionable roughness or irregularities, consistent with good industry practice. The nominal jacket thickness shall be that shown below, with the minimum wall not less than 80% nominal value.

Nominal Jacket Wall Thickness in Inches

Cable Diameter Under Jacket	Modified Polyolefin	Teflon or Tefzel	Neoprene
0.000-0.250	0.045	0.010	0.072
0.251-0.500	0.045	0.015	0.087
0.501-0.750	0.060	0.021	0.1
0.751-1.000	0.080	0.021	0.1
1.000-1.500	0.080	0.025	0.115
1.501-2.000	0.11	-	0.135
2.001-2.500	0.13	-	0.152
2.501-3.000	0.14	-	0.195

22.16.5 Wire Wrap

Wire wrap connections may be used in selected electronic applications, where approved. Where used, the following standards, as a minimum, shall be followed:

A. Only soft or annealed oxygen-free solid copper conductor shall be used.

B. Wire size shall be No. 28 AWG.

C. A silver conductor coating, with a minimum coating thickness of 40 micro-inches, shall be applied to the wire.

D. Wire shall have "MIL-ENE" insulation, or approved equal manufactured to MIL-W-81822/1A. The insulation shall have a minimum 300 VAC/VDC voltage rating and shall allow a 135°C maximum conductor temperature.

E. Wrapping shall be "modified" wrap, nominal 7-1/2 turns, including 1-1/2 turns for strain-relief.

22.17 WIRING

22.17.1 General

All car wiring shall be in conformance with Chapter 3 of the National Fire Protection Association's Publication NFPA No. 70, National Electric Code, and the AAR Manual of Standards, Section F S-538, "Wiring Practice and Rolling Stock Standard," except where otherwise specified, and except that all wire shall be as required in this Specification. Circuit protection shall be in conformance with Chapter 2 of NFPA publication No. 70, Article 240.

22.17.2 Wire Handling

All wiring shall be performed by qualified, experienced wiring personnel using appropriate tools for stripping insulation, cutting, tinning, soldering, harness making, attaching terminals, and other wire fabrication tasks. All wiring tools and equipment shall be used as recommended by the tool and equipment manufacturer.

Wire shall be protected from damage during all phases of equipment manufacture. Wire shall not be walked on, dragged across sharp or abrasive objects, kinked or twisted, or otherwise mishandled. The ends of wire shall not be permitted to lay on wet floors or other damp areas where moisture may be absorbed into the conductors. Wire subjected to the above or similar damage shall be discarded or otherwise dispositioned subject to approval.

When removing insulation, wire strands shall not be nicked or broken in excess of the requirements of FAA Specification No. AC 43.13-1A, Section 449, "Stripping Insulation."

In addition, the following criteria applies:

Wire Size	Maximum Number of Nicked Strands*
Wires smaller than No. 10	None
No. 10 through 1/0	7.4%
Above 1/0 through 1600/24	4.4%
Above 1600/24	Graduated scale

* Definitions:
1. A cutoff strand shall count as two nicked strands.
2. A nick is defined as 25% or more of the strand area damaged, or cut more than 33% of its diameter.
3. Longitudinal scratches in a copper strand are not considered cause for rejection.

22.17.3 Wiring Layout and Installation

22.17.3.1 Wire Harness

The layout of wiring, for both car and equipment, shall be designed in advance of its installation and in cooperation with the suppliers of the related equipment. Wiring shall be pre-fabricated into standard harnesses, wrapped and tied with a high strength, waxed lacing cord designed not to invade the wire insulation or nylon wire ties. Harnesses shall be installed with identical arrangement and location in each car having similar equipment. Separate harnesses shall be provided for major circuit groups or types, or as required for specified circuit separation. All circuits and branches shall be separable by means of terminal boards to isolate portions from others for troubleshooting and searching for undesired grounds. All circuits subject to periodic high potential tests shall be so arranged that they can be conveniently set up for the tests.

Alternative methods for fabricating and installing wiring, which are standard carbuilder practice, will be considered for approval.

Harnessed wires shall not be installed in conduit. Wires from different conduits or other openings shall not be harnessed together with wires running within the box or entering the box

through another entrance point. Each harness, wire trough, conduit, or group of wires between equipment enclosures shall contain a minimum of 10% spares, but no fewer than two spares for each wire size.

22.17.3.2 Circuit Separation

Circuits shall be physically separated to reduce the possibility of unsafe conditions, interference, or equipment damage.

The following major circuit groups shall not be harnessed or bundled together, shall not run in the same conduit, and shall be physically separated and secured in enclosures, wire ducts, junction boxes, or other wire routing devices:

A. ATC/ATS/Cab Signal circuits
B. High voltage circuits
C. AC circuits
D. Communication circuits
E. Battery voltage level circuits
F. Semiconductor gating voltage level circuits
G. Network circuits
H. Third rail circuits
I. Conductors carrying in excess of 100 Amps

Wires that are connected in circuits with potentials differing by 50 volts or more shall be separated by a physical barrier. Whenever possible, the wires shall not be cabled together and shall not be placed in the same conduit, junction box, or enclosure. Where a raceway, duct, junction box or enclosure is divided into two or more distinct areas by metallic partitions, each area may be considered separately in the application of this rule.

Where it is impossible to avoid having wires at different voltages in the same equipment enclosure, the wires shall be physically separated, bundled, and secured separately such that contact between wiring is not possible. All wiring within an enclosure shall be insulated for the highest voltage in the enclosure, unless approved otherwise. All wiring connected to a piece of apparatus shall be insulated for the highest voltage connected.

Wiring connected to transient-generating apparatus, such as unsuppressed contactor coils, shall not be run adjacent to wiring carrying signals to, from, or between semiconductor circuits, logic circuits, vital no-motion circuits, or communication circuits. In cases in which adequate physical separation is impossible, shielded wire shall be used for all conductors involved.

22.17.3.3 Wire and Cable Runs

Wire runs shall be continuous and unbroken between connection points, shall be supported at no greater than 2 foot (610 mm) spacing, and be protected at each support point against mechanical crushing and abrasion. A water-tight bushing and drip loop shall be provided on all exposed cable entries. All cable bundles and wires shall be routed a minimum of 1-inch (25.4 mm) above the bottom of equipment enclosures.

All undercar wiring smaller than No. 6 AWG shall be run in closed wire ducts, conduits, or open wire mesh wireways in an approved manner. Wire and cable shall be secured within ducts or open wireways, including each entrance and exit point, to prevent chafing movement. Wire ducts and conduits shall be of waterproof construction. Permanently retained watertight strain relief bushings, with insulated throat liners, of an approved design, shall be used at locations where wires, cables, or harnesses enter or exit conduit, ducts, apparatus, and equipment enclosures. In addition, strain relief bushings on equipment enclosures shall include a permanently retained O-ring type seal.

Lead wires to resiliently-mounted electrical apparatus shall be carried in conduit to a point as close to the apparatus as possible. The length of the leads between the end of the conduit and each piece of apparatus shall be as approved. Short runs of cables or harnesses entering or leaving conduit and apparatus shall have an approved guard mounted to the carbody to protect the wires from mechanical damage. Lead wires to solidly-mounted, electrical apparatus and equipment enclosures shall run in conduit connected to the apparatus or enclosure.

Any wiring run through the floor shall be run in ducts or conduit. Wiring, even if enclosed in loom, must not be run through partitions without suitable bushings being provided at such points of passage.

Cables shall be laid in place with sufficient slack at the bends so that cables will clear the inside bend surface of the wireway/wire duct.

All wire and cable shall be free of kinks, insulation damage, insulation abrasions, and nicked strands. Wire installation shall not be subject to accumulations of water, oil, or other foreign matter.

Wires or cables shall not pass through or over the battery compartment and shall not pass over heat generating equipment such as acceleration and braking resistors, even if the wires or cables are in conduit.

Harnesses exposed, short cable runs or harnesses entering or leaving exposed raceways shall have approved, fire-resistant flexible dielectric sleeving over the raceway edges and grommet-type insulation of any penetration holes. Wiring shall be retained to the sleeving with tie-wraps.

22.17.3.3.1 Cable Cleating and Support

All cable and wiring exiting wireways/wire ducts, or that which is not installed in conduit shall be cleated using fiberglass or molded neoprene rubber split-block cleats with clamp stops to prevent over-compression of the wire insulation. The cushioning material shall be fire retardant insulating material with a durometer of 50 to 60 meeting the requirements of Section 22.7. If neoprene rubber split-block cleats are used each cleat shall have a stiffener of at least 10 gauge material on the side away from the mounting bracket which shall act to spread the bolt clamping force over the entire length of the cleat. Bolts shall have lock nuts. The Contractor shall minimize the quantity of different configuration cable cleats.

No. 6 AWG or larger insulated wire may be cleated in place without conduit, duct or open wireway. However, in the areas over the truck, in the wheel wash and not

protected by underfloor mounted equipment, the wire shall be mechanically protected by an open mesh, expanded metal or other type of approved guard. The guard may be attached to the bottom of each cleat with the cleat clamping bolts or other approved arrangement.

Cleats shall be designed to grip each cable individually and firmly, but without causing any damage to cable insulation, including cold flow of the insulation. Each cable in the cleat shall have its own cutout sized to the correct wire diameter. Cleated cables shall be routed and supported such that they cannot, under any combination of forces and car movement, touch each other or any other part of the car, except the cleat cushioning material.

Wire and cable runs shall be continuous and unbroken between terminations and shall be supported at not greater than 24-inch intervals in ducts, open wireways or when cleated. The wire shall be protected at each support point against mechanical crushing and abrasion.

Wire splices will not be permitted, except with express written approval and in accordance with the wire splicing requirements of Section 22.18.9.

Concealed wires, such as within conduits and wire ducts shall be such that wires may be replaced or added to without the removal of other than an access panel at each end of the wire. It shall not be necessary to disconnect or disassemble conduit to accomplish this task.

Wiring run in loom shall not be carried over a potential chafing hazard.

Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them. This applies to all current carrying wires, cables or buses on the vehicle.

22.17.3.3.2 Wire Securement and Termination

All wiring shall be secured and protected against movement, chafing, and any contact with conductive, sharp, or abrasive objects including the inside surfaces of wire runs.

No wiring shall be secured directly to the car structure, equipment enclosures, or any metallic surface. Wiring securing devices shall be either completely non-metallic or metallic with a resilient, insulating member between the wiring and the metallic portion of the device.

All wiring shall be located and secured such that normal equipment motions, maintenance access, heat sources, and the environment do not damage or reduce the life of the wiring.

Junction boxes, with terminal boards, shall be used, as required, for wire terminations. Harness connections to the boxes, as well as internal wiring to terminal boards, shall be as specified in Section 22.18.2. Exterior junction boxes shall be weathertight.

In cases where it is necessary to anchor wires or cables to metallic parts of the car, cleats or approved stainless steel bottle clamps shall be used. Wires and cables shall not be allowed to chafe or rub against any part of the car or each other under any circumstances.

Wire and cable dress shall allow for sufficient slack at equipment terminals to provide for movements induced by shock and vibration, equipment shifting, alignment, cover removal and component replacement. Sufficient lengths shall be provided at points of termination for additional re-terminations without applying tension to the wire and without splicing the wire, as follows:

A. No. 10 AWG and smaller: Three re-terminations
B. No. 8 AWG and larger: Two re-terminations

A drip loop shall be provided on all exposed wires and cables and assemblies to prevent fluid runoff into connected equipment.

Spare wires, which are part of a wire harness, shall be bundled separately inside of the equipment box to which the harness is being terminated. Spare wires shall have enough length to reach any location within the box, including sufficient slack for the required number of re-terminations. The spare wire "break-out" bundle may be ty-wrapped to the main harness, but shall be easily removed from the main harness without disassembling it. The ends of the spare wires shall be insulated against inadvertent contact with any nearby conductive surfaces or terminals.

Wire tying devices shall be of such material and construction that they will adequately retain the wires for the life of the wiring and shall be resistant to ozone and ultraviolet light if they are installed outside of the carbody.

If approved, non-UV resistant and non-ozone resistant wire tying devices may be used in the interior of the car. Wire and cable ties shall be trimmed and located to eliminate any hazard to personnel from sharp edges. Wire tying devices shall be snug, but shall not be so tight as to cause indentation and cold flow damage to the insulation. Wire tying devices shall be mechanically fastened to a permanent structure. Adhesive-installed mounting bases shall not be used for ties or for cable support.

All wire bundles and cables within an enclosure shall be supported by the use of tape rails, shall be spaced away from the equipment box structure, metal edges, bolt heads, and other interference points, and shall have electrical clearance from the covers, regardless of the insulation properties of covers. Wire bundles shall be located above or alongside the apparatus rather than at the bottom of the box wherever possible. In all cases, wire shall be a minimum of 1 inch above the bottom of the box. Wire entry into control or junction boxes shall not be permitted through the bottom of the box.

Truck wiring shall be designed to ensure sufficient slack, and shall be provided with clamp supports and abrasion protection. T-splices will not be permitted.

All jumpers, jumper heads, and jumper receptacles shall be sealed in an approved manner to prevent the entry of water at any operational speed of the car.

Any wiring needed to calibrate and test car functions shall be a part of the permanent car wiring to enable SFMTA to conveniently maintain the equipment. This wiring shall terminate in approved connectors in the respective control groups and cabinets.

SFMTA desires to have wiring and cabling readily accessible for inspection and maintenance. Extensive wiring and cabling in the vehicle interior is contrary to accessibility, even though access panels, false floors, and other portals may be provided. To control this, the Contractor shall submit a complete wiring plan for approval.

22.17.3.4 Circuit Shielding

Wire shields used in trainline circuits shall be continuous up to the car's electrical coupler contacts, including contacts of the jumper cable connector at the intermediate couplers. The wire shields shall be connected through all applicable connectors and junction boxes. Circuits shall be categorized. Shields contained in one circuit category shall not be interconnected with shields contained in another category. Shields used to protect against interference shall not carry signal current.

Shields on low-level signal wires shall not be interconnected with shields on high-level signal wires in the same category. Each group of shields (other than at the electric couplers) shall be carried through on a connector pin or pins, or on terminal strips which shall be in the immediate proximity of the categorized group of circuits. Loops due to interconnections of shields shall not be permitted.

Coaxial cables used as constant impedance transmission lines shall be terminated as dictated by the circuit termination design and shall not be considered to be shielded conductors. Triaxial cables may be used as coaxial impedance transmission lines with the outer conductor employed as an RF shield.

The following three items shall be considered as guidelines and are not absolute requirements:

A. Shields used to suppress electromagnetic interference (EMI) at all frequencies shall be terminated only at the low potential side of the interference circuit, at the termination which exhibits maximum susceptibility.

B. Shields used to protect against the effect of, or to exclude, EMI at frequencies below 150 kHz, shall be terminated either to the low potential side or at the balance point of the protected circuit at the termination which exhibits maximum susceptibility.

C. Cables requiring both audio frequency (AF) and radio frequency (RF) shields shall be electrically isolated from each other. The resistance between these circuits shall be at least 500 megohms when 500 volts dc is applied. Double shielding shall be required on circuits that are both AF-susceptible and RF-susceptible.

22.17.4 Insulation Resistance

Insulation resistance to ground at 500 or 1000 VDC, as applicable for each nominal voltage circuit group when measured with an insulation resistance tester (megger), shall give no less than the following resistances, on a vehicle with all circuit breakers closed, and all circuits complete:

Nominal Circuit Voltage (DC or ACrms)	Minimum Insulation Resistance
Below 90 volts	2 megohms at 500 VDC
90 volts to 300 volts	4 megohms at 1,000 VDC
Above 300 volts	5 megohms at 1,000 VDC

The Contractor shall ensure that these requirements will be met under the most severe conditions of temperature and humidity.

22.17.5 Marking

The Contractor shall devise, and submit for approval, a wire and terminal designation system that shall coordinate all electrical circuits in the car into a unified system. The system shall identify all wiring, including circuit return wiring, and terminals according to their respective circuit function(s) and shall accurately correlate with the car schematic diagrams. Each circuit shall be individually designated from point to point. Common designations for return circuits are not permitted. Alternative designations may be approved for small standard assemblies such as PA amplifiers.

All wires and terminals shall be clearly identified. Wires attached to terminal studs shall also have a marker indicating the terminal stud to which it is attached.

Identification of wires and terminals shall be by white or yellow permanent markers with black printing. All wires shall be marked every 6 inches within 12 inches of the end of the wire and every 12 inches along the entire length of the wire. Wire markers shall be stamped in two places, approximately 180 degrees apart, around the cylindrical portion, and should be consistently oriented for viewing throughout the vehicle and equipment to facilitate readability of the marking. Wires in multiple-conductor cables shall be color-coded.

For pre-manufactured, multi-conductor cables and for cases where individual circuit identification markers may be approved the following requirements apply:

A. All wires and terminals shall be clearly identified. Wires attached to terminal studs shall also have a marker indicating the terminal stud to which it is attached.

B. Identification of wires and terminals shall be by white or yellow permanent markers, with black printing or by continuous wire marking printed on the wire. All wires shall be marked 6 inches (152 mm) from of the end of the wire, every 12 inches (305 mm) within 10 feet (3.05 m) of the end of the wire, and every 24 inches (610 mm) over the remainder of the wire. Wire markers shall be stamped in two places, approximately 180 degrees apart around the cylindrical portion, and should be consistently oriented for viewing throughout the vehicle and equipment, to facilitate readability of the marking. Wires in multiple-conductor cables shall be color-coded.

C. Wire markers shall meet the adherence and solvent resistance requirements as specified by MIL-M-81531 Sections 3.4.2 and 3.4.3, latest revision, and shall withstand all combinations of ambient and equipment temperatures. Hand printing is prohibited.

D. For cable identification, the contractor shall use a basic identification system in conformance with ANSI/IEEE 200 and shall submit the system selected for review.

Color coded wires may be approved as an alternative to marking in small standard assemblies such as PA amplifiers. Also, approval may be granted for relief from the marker requirements, on a case-by-case basis, for electrical panels or around interconnecting jumpers within a panel.

22.17.6 Pulling Compound

Pulling compound shall be non-conductive, non-hygroscopic, non-odorous non-corrosive, non-flammable, shall not support bacterial activity, shall not attract vermin, and shall be compatible with all wiring insulation used.

22.17.7 Solder

Solder shall be in accordance with ASTM B 32, Grade Sn 60. A flux of non-corrosive type shall be applied immediately before soldering.

22.17.8 Tape

Electrical tape shall be polyvinyl chloride in accordance with AAR Standard S-540 of Section F of the AAR Manual Standards and Recommended Practices, or equivalent approved railway practice. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

22.18 WIRE AND CABLE CONNECTIONS

22.18.1 General

All equipment enclosures and junction boxes, except primary power circuits, shall be fitted with terminal boards or connectors. Primary power circuits shall be fitted with compression terminals and knuckle joint connectors as described herein.

The Contractor shall submit the proposed design and product line for all connections for approval. Terminal boards with M4 or Number 6 or smaller screws and quick-disconnect terminals, other than those stated herein, will only be permitted with approval.

22.18.2 Terminal Boards and Terminal Points

All electrical terminal points and terminal boards shall be one of the following types:

A. Stud type in accordance with MIL-T-55164A
B. Binding head screw type in accordance with MIL-T-55164A, only where approved
C. An approved constant tension spring clamp type, for wire sizes not to exceed AWG No. 12.

Stud-type terminal points shall have brass studs and connections, each of which shall be locked using a single brass nut with flat brass washer and a plated spring-type lock washer. Studs, nuts, and washers may also be made of corrosion-resistant, plated steel, where approved.

Each board or connector shall have the necessary number of terminations plus a minimum of 10 percent spares, but not fewer than one spare unless approved.

Threaded studs shall have a minimum of 2-1/2 threads exposed beyond the final nuts and shall not project more than 2-1/2 threads plus 1/4 inch (6.4 mm) beyond the final nuts, unless otherwise approved. Adequate space shall be provided to permit connecting wire terminals with standard tools. All terminals shall be properly torqued and marked to ensure sound connections. Spacers shall not be used.

Jumpers between terminal board points shall be brass or plated steel. Wire jumpers between adjacent terminals of terminal boards will not be permitted.

An approved permanent marking strip on each terminal board shall be provided and attached adjacent to the wire junction point to identify the wires attached thereto and/or the wires connected to terminal boards shall have the terminal point location printed on the wire.

A maximum of two terminals shall be connected to any one binding screw. A maximum of four terminals shall be connected to any one threaded stud, provided that there is no interference between terminal barrels. On terminal boards, the wiring shall be arranged so that no more than two terminals are connected to a stud, from each side of the terminal boards.

22.18.3 Wire Terminations

Terminals and connections used throughout the car shall be the mechanical, solderless, crimp type made by AMP Incorporated only. All terminals for the same wire size shall be crimped with the same model tool. The Contractor shall minimize the total number of crimping tool types needed for all crimp connections. Terminals fitting wire sizes AWG No. 10-22 shall require no more than three tool models to provide certified crimp connections. The Contractor shall submit the proposed product line for approval as well as the contractor's standard training, certification, and testing procedures for crimping. Terminals to be approved shall be tested to Military Specification MIL-T-16366F for temperature rise, voltage drop, vibration, current overload, and corrosion. Test results shall be submitted for approval on a by part number basis.

Terminals and connections shall be attached to the wiring with proper crimping tools and dies as recommended by the manufacturer. The terminals used on conductors of size No. 10 AWG or smaller shall be of a type that securely grips and holds the insulation of the conductor, unless otherwise approved. Terminals shall be ring lugs in accordance with Military Standard MS-25036; spade and hook-type terminals shall not be used. Corrosive protection shall be provided for all base materials.

Conductors subject to motion relative to the terminal shall be protected by suitable means to prevent breakage of the conductor at or near the terminal. Sufficient slack shall be provided in

all wires and cables to prevent breaking or pulling out of bushings and terminals. A maximum of one wire shall be crimped in any one terminal.

Wherever several wires are connected to terminals of a terminal strip on a device which is removable from the car for maintenance, the wires shall be terminated, with double ring terminations that shall be screwed to an insulating fanning strip which shall serve to keep the terminations in the correct relative locations while removed from the device, unless otherwise approved.

The use of cage-clamp type compression connections will be permitted on a case-by-case basis.

22.18.4 Power Cable Terminations

Power cables shall be terminated with an approved compression terminal (AMP only). Sufficient cable slack shall be provided to preclude breaking or pull-out from bushings or terminals and to allow two terminal changes. Cable conductors shall be clean prior to installation of terminals. Compression terminals shall be applied using tools and procedures recommended by the terminal manufacturer for that purpose. Swaging tools shall be of a type that ensures complete swaging in every case.

22.18.5 Motor Lead Terminals

Traction motor terminals shall be of the glad-hand type or the two bolt type, with crimped or soldered tube type lug. The termination shall be covered by an approved insulated sleeve, such as Mark Equipment Co. Part No. M105. The sleeve shall be clamped with stainless steel worm screw-tightened hose clamps. A neoprene bushing shall be used between the cable and sleeve, if required, to make a good fit for a water-tight seal between the sleeve and cable at the clamp.

22.18.6 Cable Connectors

All cable connector applications shall be approved.

All cable connectors shall conform to DIN 43 650A/ISO 4400, or an equivalent standard as approved. They shall employ removable crimp contacts of the correct size for the wire being terminated. Except as noted below, the connector contact area shall be plated with a minimum of 0.000030-inch of gold over a minimum of 0.000050-inch of low stress nickel. For high current applications, the connector contact area shall be plated with a minimum of 0.00010-inch of silver. Adjacent connectors shall either use different inserts or different insert orientations to prevent erroneous connections. The receptacle half of all cable connectors shall be rigidly mounted.

Where 1/4-turn, bayonet-lock connectors are specified they shall conform to all provisions in, DIN 43 650A/ISO 4400 or an approved standard, except for the screw coupling requirement.

All cable connectors used in exterior locations shall be of the environmental watertight variety. Cable connectors shall be equipped with sealing gaskets on the front mating surface and on the back where the cable enters. Bolts within the connector shall be long enough to ensure that there is sufficient room to terminate the cable wires within the connector body. The cable jacket shall

be held by a clamp within the connector body. Unused connector pin/socket positions shall be sealed with either connector contacts or plastic sealing plugs designed for that purpose.

Plastic bodied connectors shall not be used in exterior locations.

Except as provided above all cable connectors in exterior locations, shall be 1/4-turn, bayonet-lock, quick disconnect type CIR connectors as made by Litton-Veam SPA, or approved equal.

Connectors in high vibration or high motion areas, such as speed sensors and trainline jumpers shall have the wire connections soldered and potted. A watertight jacket shall be molded over the cables and connectors to form a unitized assembly. The contractor shall conduct an approved vibration test on these unitized assemblies.

In waterproof interior locations, the use of non-weatherproof connectors will be allowed as approved. All other connector requirements specified in this section which do not directly apply to weatherproofing shall be met.

22.18.7 Quick-Disconnect Terminals

Approved quick-disconnect terminals shall be utilized to facilitate maintenance and inspection. They shall provide positive terminal engagement and be shock and vibration proof. All terminals shall be provided with insulation equal to that of the wire. No "push-to-fit" (FASTON) type terminals will be permitted. If "push-to-fit" type terminals are allowed they shall be the locking tab type. Application of these type terminals will be on a case-by-case basis and shall be limited to low voltage, excluding under car application, and non-heat generating resistors (above 10 watts).

22.18.8 Grounding Return Connections

22.18.8.1 Grounding

Grounding connections to the carbody and equipment shall be made through copper pads of an adequate area, silver soldered or brazed to the respective carbody and piece of equipment. All ground pads shall be visible and accessible for inspection and troubleshooting. The ground connections shall be attached by a bolt, washer, and nut designed for the purpose. The Contractor may propose alternate grounding connection methods with proven service history in similar environments.

All equipment enclosures and shock-mounted equipment shall be grounded with flexible, strap-type, grounding leads bolted between a carbody grounding pad and the equipment's grounding pad. Braided, strap-type leads shall be used where there is relative motion between the two items being connected. The ground strap termination method shall apply uniform pressure to the conductive surface and the current density shall not exceed the bonding requirements of Section 22.18.8.2.

The Contractor shall submit, for approval, a complete grounding scheme, which shall indicate the means by which it is proposed to prevent currents from passing through journal, motor, and truck-center bearings. Refer to other sections of this Specification (17.7) for ground brush and

related requirements. Low voltage and high-voltage circuits shall not be grounded to the same ground.

22.18.8.2 Bonding

All grounding and bonding jumpers and straps shall be sized to handle fault current and lightning discharge current, for which the voltage drop shall not exceed 25 volts. The bonding method employed shall not produce a DC resistance in excess of 0.0025 ohms, or more than 0.025 ohms at 150 kHz for any applied AC voltage. Grounding and bonding jumpers, and brazed shunt straps shall be "extra-flexible." Bonding requirements shall conform to NEC regulations.

22.18.9 Wire Splicing

Splicing of conductors shall be prohibited except with approval, on a case-by-case basis. Splicing of conductors in conduit will not be permitted. In the event a splice is approved, it shall be in a junction box and the spliced joint shall be mechanically as strong and have the same conductivity as any other part of the conductor. The splice shall be an insulated permanent crimp splice in accordance with Military Specification MIL-T-7928G, Type II, Class I, and shall be installed with the crimping tool and die of the splice manufacturer. All splices shall be insulated with a self-sealing, weathertight, seamless shrink tubing. The outside diameter of the spliced portion of the cable after the insulation is applied shall not exceed the outside diameter of the unspliced portion by more than 40%. Splices shall be identified in the integrated schematic.

22.19 CONDUIT

22.19.1 Types

All conduit and conduit couplings shall be of an ANSI-approved type. With the exception of truck areas, all conduit shall be of the Aluminum Association's recommended aluminum alloy or galvanized steel (no EMT tubing is permitted). Conduit installed on the trucks or in underfloor areas over the trucks shall be standard weight, galvanized steel with threaded fittings. All conduit ends shall be deburred inside and out to remove sharp edges and all pieces shall be blown out with compressed air and cleaned before installation to remove filings and other foreign material.

Rigid aluminum conduit shall consist of seamless, rigid, aluminum alloy conforming to ANSI Standard C-80.5 and to the requirements of Underwriters Laboratory Standard UL-6. All threads shall be covered with an oxidation-inhibiting compound. Aluminum fittings shall be used to assemble aluminum conduit and shall be made to the same grade and alloy as the conduit.

Steel conduit shall be mild steel in standard lengths with threaded ends and hot-dipped zinc-coated exterior and interior surfaces. It shall be free of burrs and projections, circular in cross-section, of uniform wall thickness and shall conform to the requirements of ANSI Standard C-80.1. The threads per inch and length of threading shall conform to ANSI Standard B-20.1: 1983 on Pipe Threads.

Steel fittings shall be used to assemble steel conduit. Elbows, nipples, and couplings shall be made of the same grade of steel as that employed in the conduit. All fittings shall be treated, coated, and threaded according to the requirements for zinc-coated, rigid steel conduit and shall conform to Underwriters Laboratory Standard UL-6.

Flexible conduit, if used undercar in areas exposed to impact, shall be watertight and interlocking steel strip-protected, with an approved rust resistive coating. Non-steel strip protected flexible conduit may be used on interior applications where approved. PMA style conduit may be used only with application-specific SFMTA approval.

22.19.2 Size and Fill

Conduit shall be sized such that the sum of the cross-sectional areas of the conductors and their insulation does not exceed 40% of the cross-sectional area of the conduit for three or more conductors. For two conductors, a limit of 31% shall be used, while for a single conductor, a limit of 53% will be permitted. Where conduit having a length not exceeding 24 inches without bends of more than 15^{o} are used between enclosures, a maximum fill of 60% will be permitted.

22.19.3 Installation

A run of conduit between junction boxes and/or pulling outlets shall not contain more than the equivalent of four quarter bends, 360 degrees total, including the outlet fittings. Bend radii at the inner surface of the bend shall be no less than eight times the nominal inside diameter of the conduit.

All conduit bends and offsets used shall be made by the use of special forms or tools and shall have the largest radius possible so that wires can be pulled without the use of tackle or power.

Conduit shall be securely clamped with all runs electrically grounded to make a continuous ground. Suitable approved insulation to prevent electrolysis shall be provided where steel and aluminum are in contact.

All conduit shall be arranged to prevent moisture traps and shall drain toward control boxes, except that all open-ended conduits shall be installed in such a manner as to ensure gravity drainage out the end. The conduit arrangement and installation shall be subject to approval.

22.20 CONDUIT FITTINGS AND JUNCTION BOXES

22.20.1 General

The conduit fittings and junction boxes for car wiring shall be as manufactured by the Contractor or by a supplier of a comprehensive line of parts. The Contractor shall submit the proposed product line for approval. All conduit fittings and junction boxes shall be water-tight as required for the application and shall be provided with gasketed covers as described in Section 22.20.4 such that the box is environmentally sealed equivalent to NEMA Standard No. 250, Type 4. All conduits and their connections to electrical equipment shall be installed to make a continuous ground.

22.20.2 Boxes

All exterior junction boxes shall be fabricated of steel with a minimum wall thickness of 14 gauge. All exterior junction boxes shall be weatherproof and shall be connected in such a way that drainage from equipment groups will not pass through conduit into the junction boxes. Interiors of all junction boxes shall be primed and then protected with a white, insulating epoxy powder coating as specified in Section 22.23.4.

22.20.3 Conduit Interface

The open ends of conduit shall be provided with strain relief type fittings with extended rubber bushings, bell-mouth fittings, or insulated throat box connections as approved. All conduit entries into removable equipment boxes shall be secured by means of a bolt-on watertight access panel.

22.20.4 Covers

All junction box covers shall be retained by compressive spring-type latches or captive screws as approved on a location-by-location basis. All fasteners used in junction boxes shall be stainless steel. All covers shall be designed to accept or mate with a bulb-type clamp-on seal.

22.21 WIREWAYS

All wireways shall be of rigid steel or aluminum construction with an approved powder coat system to minimize the risk of oxidation and rust formation. The trays shall be adequately supported throughout their entire length in an approved manner. There shall be absolutely no sharp edges. The trays shall be completely de-burred before installation on the vehicles. Grommet clamps shall be provided at all locations where cables or wires enter or leave the wireways. Under no circumstances shall leads be draped over the edge of the wireways, with or without wireway edge protection.

The wireways shall be routed such that they avoid

A. Sources of heat such as propulsion and dynamic brake grid resistors
B. Wheel splash areas
C. Areas along the vehicle where the trays may be subject to foreign object damage.

Wireways shall be located to provide access to the harnesses contained within for maintenance action.

Wireways shall be designed to prohibit the collection of dirt and debris, and shall be perforated, without compromising their requisite strength, to permit ventilation and drainage.

Bends in wireways shall be avoided; however, if they are required, approved protection shall be provided to avoid insulation chafing at the bends.

Wireways will be permitted in approved exterior and ceiling locations only. They shall be permitted in the carbody sidewall area only in areas that are accessible for maintenance. Only conduit will be permitted in the carbody.

Wireways shall not contain more than 30 current-carrying conductors at any cross-section. The sum of the cross-sectional areas of all conductors contained at any cross-section of a wireway shall not exceed 40% of the interior cross-sectional area of the wireway.

All wire and cable shall be securely fastened within wireways to eliminate movement and resultant chafing.

Grounding and bonding jumpers, in accordance with 22.18.8.1 and 22.18.8.2 shall be applied to all wireways carrying conducts greater than 70V.

22.22 WELDING, BRAZING, AND SOLDERING

22.22.1 General

The Contractor shall be responsible for the quality of their own welding and brazing and that done by their Suppliers and Subcontractors Surfaces for welding shall be clean and free from paint, oil, rust, scale or other material which is detrimental to welding.

22.22.2 Structural

All structural welding shall be in accordance with the American Welding Society AWS D1.1/D1.1M:2008 "Structural Welding Code -Steel"; AWS D1.2/D1.2M:2003 "Structural Welding Code -Aluminum"; AWS D1.3/D1.3M:2008 "Structural Welding Code -Sheet Steel"; AWS D1.6/D1.6M:2007 "Structural Welding Code- Stainless Steel", or AWS C7.4/C7.4M:2008 "Process Specification and Operator Qualification for Laser Beam Welding", as appropriate for the materials, thicknesses and processes that are used in fabrication. The requirements for dynamically (cyclically) loaded structures shall be applied. Cast steel welding shall be according to ASTM A 488/488M "Steel Castings, Welding, Qualification of Procedures and Personnel." Resistance welding shall be in accordance with AWS D 17.2/D17.2M: 2007. Prior to conducting any AWS C7.4/C7.4M:2008 Procedure Qualifications the contractor shall submit for approval the tests that are proposed for those qualifications and the technical justification for those tests.

Codes and standards other than those referenced in this specification may be submitted to SFMTA for approval only if they meet or exceed those that are referenced in this specification The submittal shall include technical justification demonstrating that the proposed substitution meets or exceeds the Codes and standards referenced in this specification.

All structural welding procedures shall be qualified by testing. Pre-qualified welding procedures are not allowed. All submitted welding procedures must be accompanied by applicable procedure qualification records.

22.22.3 Welder Qualification

Welders shall make only those welds for which they have been qualified according to the requirements of the governing code or standard. Records of welder qualification tests shall be made available for review.

22.22.4 Inspection

The Contractor shall inspect all welds, brazed joints and soldered joints as required by the applicable Code as noted in paragraph 22.22.2, 22.22.7, 22.22.8, 22.22.9, 22.22.11 or 22.22.12. As a minimum, they shall be visually inspected to the acceptance criteria of that Code by personnel meeting the requirements of that Code.

The contractor shall submit for approval the qualification category and the justification for the selection of that category for each weld that is done in accordance with AWS C7.4/C7.4M:2008. (See AWS C7.4/C7.4M:2008 paragraph 1.2 for qualification categories) The Contractor shall also submit the discontinuity limits and their justification for those limits if they intend to deviate from those that are suggested by AWS C7.4/C7.4M:2008.

The Contractor shall inspect all l welds according to the applicable Code or standard. In addition to visual inspection specified for all welds, nondestructive surface inspection (dye penetrant, ultrasound, radiographic or magnetic particle methods, as appropriate and approved by SFMTA) shall also be used to inspect all first production welds. Subject to the approval of SFMTA, the Contractor shall specify a nondestructive inspection sampling rate for all subsequent welds.

On the first structure, all full penetration welds shall be nondestructively, volumetrically inspected (ultrasonic or radiographic methods) according to the applicable Code or standard's requirements. The Contractor shall specify a random sampling plan for volumetric inspection of subsequent full penetration welds for approval. The minimum acceptable inspection plan shall require inspection of one portion of a full penetration weld for every 200 production welds (one production weld is one foot in length) made. The proposed test welds shall be selected from among welds that are most critically loaded as decided by calculations or load test results. With approval, destructive sectioning and metallurgical examination may be substituted for some or all of the required volumetric inspection requirements for production welding.

On the first structure, all dissimilar metal welds or braze-welds (usually stainless to carbon or LAHT steel ring welds) shall be nondestructively inspected by magnetic particle or dye penetrant methods. Sample dissimilar metal welds shall be sectioned and examined metallographically to determine heat affected zone (HAZ) hardness. Stainless to carbon or LAHT steel weld HAZ shall not exceed 400 VH (Vickers Hardness). Other dissimilar metal welds or braze-welds shall be limited as determined by the Contractor and approved by SFMTA. The Contractor shall submit a random sampling plan for additional metallographic examinations of dissimilar metal welds for approval. The minimum acceptable sampling plan shall require inspection of one dissimilar metal weld sample for every 300 production welds made.

22.22.5 Post-Weld Cleaning Requirements

All welds shall be cleaned to remove flux and loose spatter. Welds exposed to passengers or on sliding contact surfaces of truck frames and bolsters shall be completely cleaned of all spatter.

22.22.6 Contractor Documentation

All welding and brazing documents and their subsequent revisions; such as, but not limited to Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR), Resistance Spot Welding Schedules (RSWS), and Welder Performance Qualifications (WPQ) shall be submitted for approval before application. All structural WPSs shall be qualified to meet impact requirements of this specification. Specifications of welding electrodes, welding wires, shielding gases and base metals shall be submitted for approval before their application.

22.22.7 Special Welding

Welding Procedures Specifications and their Procedure Qualification Records for other combinations of metals or conditions, applications or processes not covered by the Codes and standards as listed in this document, shall be submitted for approval.

Galvanized steel shall not be welded to stainless steel.

22.22.8 Resistance Welding

Resistance welding of stainless or carbon steels shall be in accordance with AWS D 17.2/D17.2M: 2007, Class B for structural applications and Class C for non-structural applications. Contractor-proposed deviations from AWS D 17.2/D17.2M: 2007, including, but not limited to, weld nugget diameter, tension shear strength, and minimum spacing, shall be submitted and approved before application on production hardware.

Surface indentation for exterior resistance-welded areas exposed to passenger view, regardless of Class shall not exceed 10% of *t* or 0.005 inch, whichever is greater. For exposed welds, the Contractor shall vary welding parameters and conditions within their acceptable ranges to minimize indentations. Surface burn and discoloration shall be removed by chemical cleaning, or an approved equal method, and sanding or polishing to match the surrounding surface. Spot welds made with an electrode(s) on one side through the work piece to a grounded platen or fixture shall have the weld nugget formation and size verified by ultrasonic measurement on a sampling basis, as approved by SFMTA.

Design strengths higher than standard certification and production strength requirements shall be qualified according to AWS D 17.2/D17.2M: 2007 Section 4.5.6 for each thickness. This requires a test lot size of 180 Class B or 50 Class C spot welds. Additional thickness combinations with the same increased strength ratio may be qualified by 25 spot weld shear tests plus three macro-sections. Twenty (20) of the 25 shear test specimens may be recorded from production witness tests taken from 20 consecutive production days (not calendar days). The Contractor shall submit records of the welding parameters, ultimate shear strength, weld diameter, and weld penetration for approval.

22.22.9 Resistance, Spot Weld and Intermittent Weld Spacing

Spacing of resistance and spot welds shall be according to approved structural drawings. Spacing shall not exceed 2 inches plus twice the weld nugget diameter for any structural application, including carbody side sheets. RSW welds shall not be spaced closer than 2 diameters apart unless "close spaced" certification testing is performed in accordance with AWS D 17.2/D17.2M: 2007.

Intermittent fusion-weld spacing pitch shall not exceed five inches for 2-inch (minimum) weld lengths (40% minimum of length welded). Shorter pitches are permitted with shorter welds. All structural and non-structural intermittent welds shall meet the applicable AWS Code for minimum weld length and weld spacing.

22.22.10 Toughness of Welded Assemblies

The Contractor shall provide test results to prove that all welded steel structures are above the ductile-brittle transition temperature for the specified environmental exposure. Specifically, the weld metal, HAZ, and base metal shall resist service impact loads at -20 degrees Fahrenheit without brittle failure. In the absence of prior operating history, and if the Contractor's approved design does not require greater toughness, the minimum impact value for Charpy V-notch specimens shall be 15 ft-lbf. of absorbed energy at -20 degrees Fahrenheit.

22.22.11 Brazing

All brazing shall be conducted in accordance with either AWS C3.4/C3.4M:2007 "Specification for Torch Brazing," AWS C3.5/C3.5M:2007 "Specification for Induction Brazing," AWS C3.6/C3.6M:2008 "Specification for Furnace Brazing," or AWS C3.7/C3.7M:2007 "Specification for Aluminum Brazing" as applicable.

22.22.12 Torch Soldering

All structural (not electrical) soldering, defined as heating below 840°F, shall follow the recommendations contained in the AWS Welding Handbook, Volume 2 ninth edition. Procedures and personnel who do torch soldering shall be qualified through the preparation and testing of samples of production torch soldering. Test samples shall be prepared and submitted for approval before production torch soldering.

22.22.13 Welding Terms, Symbols and Definitions

All welding terms and definitions shall be as determined in AWS A3.0:2001 "Standard Welding Terms and Definitions" unless otherwise approved by SFMTA. All weld symbols shall be in accordance with AWS A2.4:2007 "Standard Symbols for Welding, Brazing, and Nondestructive Examination", International Standard ISO 2553, or JIS Z 3021 unless otherwise approved by SFMTA. The fabrication drawings will show the applicable welding symbol and identify which Welding Procedure Specification is used to make the weld.

22.23 PAINTS AND COATINGS

22.23.1 General

The exterior portion of the carbody receiving paint shall be painted as required by the Specification and in accordance with the specified color scheme, lettering and numbering. Any austenitic stainless steel portions of the carbody shall not be painted, unless otherwise specified by SFMTA for cosmetic reasons. Where stainless steel is painted, procedures shall be as recommended by the paint manufacturer for the application, and surfaces shall be properly prepared to ensure adhesion.

All painting to be applied on the carbody or any component is to be conducted in accordance with the paint manufacturer's recommendations. The Contractor and its paint supplier shall supply a touch-up procedure and assure that a continuing supply of touch-up paints in colors used on the car, suitable for spot application by spray roller or brush, will continue to be available in the United States.

22.23.2 Materials and Preparation

Preparation of the painted surface and application of painting materials for brushing or spraying shall be in accordance with the paint supplier's recommendations. All paint materials shall be used at the consistency recommended by the paint supplier. If thinners or reducers are necessary, they shall be approved by the paint manufacturer and shall be used only to the extent recommended. Painting shall be done by experienced labor, using proper equipment under competent supervision.

All painting materials for all surfaces shall be a high quality finishing system resistant to corrosion, chipping, and fading and shall retain the gloss level. All painting materials for exterior surfaces visible to the passengers or operating personnel shall be a two-part, high solids, low VOC, polyurethane paint system, or approved equal, with a solids content between 50 to 70 percent. Alternate paint systems, such as base coat-clear coat systems, or direct-to-metal paint systems will be considered if the paint performance equals or exceeds two part polyurethane. All paint and filler materials which are to be superimposed to form a finish shall be mutually compatible and shall be warranted for use as a system by the manufacturer of the components.

Metal portions of the carbody not constructed of austenitic stainless steel shall, after fabricating, be prepared for painting by grit blasting and immediately painted within a time frame suggested by the manufacturer, with an approved two-part epoxy primer, or washed with an alkaline solution, properly rinsed, phosphate coated or painted with a coat of wash (etch) primer, and then coated with an approved two-part epoxy primer. After erection of the framing structure and body sheets, all undercar metal, except stainless steel, shall receive a polyurethane finish as specified above. The color of the underframe paint shall match DuPont charcoal gray, Color No. 6334. The supplier shall submit color samples and corresponding tri-stimulus values for approval. The exterior finish shall have a gloss level greater than 80 as measured with a 60^{o} glossometer. Three samples of each primer, color, and/or base coat clear coat paint for exterior, undercar, truck frames , and any paint or powder coat used for the interior of the vehicle or

equipment shall be submitted to SFMTA for approval of gloss, adhesion, finish, and orange peel characteristics.

22.23.3 Exterior Painting

All exterior surfaces that are to be painted shall be prepared as specified and the paint shall be applied according to the paint manufacturer's recommendations. The paint shall be uniformly applied over all surfaces to be covered and shall be free from runs, sags, or other application defects. Painting shall be done in a clean, dry atmosphere at an ambient temperature as recommended by the paint manufacturer.

Before painting any car surface that is exposed to view, all dents, gashes, nicks, roughness, or other surface imperfections or depressions shall be removed so far as possible by straightening and shall be properly prepared to receive the filler material. These surfaces shall be wash primed following straightening. Any remaining dents or other surface imperfections shall then be filled with an approved epoxy-based filler and sanded smooth. The maximum allowable filler thickness shall be as recommended by the filler manufacturer for the environment and service to which it is to be exposed, but in no case shall it exceed 1/8-inch.

Exterior austenitic stainless steel shall be cleaned with an approved alkaline cleaning solution, which shall not damage any previously painted surfaces. All hidden aluminum or ferrous materials, except austenitic stainless steel, shall be given one coat of an approved two-part epoxy primer and one coat of an approved top coat.

The final painted surface shall be tested on the first car to the following criteria:

A. Hardness. Pencil Hardness tests shall be performed according to ASTM D3363. The range of acceptance shall be between H and 2H and shall be the average of ten readings taken from typical surface locations. This is a destructive test and shall require the tested surfaces to be repaired.

B. Adhesion. Adhesion shall be tested per ASTM D4541 and achieve a minimum rating as provided by the paint manufacturer. This is a destructive test and shall require the tested surfaces to be repaired.

C. Thickness. The minimum and maximum dry film thicknesses shall be provided by the paint supplier. Dry film thicknesses beyond the manufacturer's minimum and maximum recommendations shall not be accepted. Non-destructive testing shall be performed to verify final dry film thickness.

D. Paint Cure. A solvent rub test shall be performed per ASTM D5402. The test procedure requires no less than fifty double finger rubs with a cloth wetted in acetone or methyl isobutyl ketone to the painted surface. No paint color should transfer to the cloth. After 72 hours the painted surface must retain all original characteristics such as gloss and hardness.

22.23.4 Apparatus and Underfloor Equipment

All underfloor apparatus (motors, control boxes, junction boxes, brake valves, and other equipment as specified) shall be primed and painted in accordance with the following

requirements unless otherwise indicated. All other apparatus shall be painted in an approved color.

The exterior surfaces of undercar equipment enclosures and apparatus, other than propulsion control equipment, made from carbon steel shall be prepared, primed, and painted as specified in Section 22.23.3. The interior and exterior surface of all propulsion control equipment enclosures shall be coated with an approved insulating, thermosetting, resin-based, powder coating or approved equal. The interior of the boxes shall be white and the exteriors shall match the undercar paint scheme.

Parts of undercar equipment enclosures made from plastic or fiberglass shall be painted in accordance with the above requirements for metal portions except that the paint system shall be compatible with the plastic used, and an insulating coating need not be applied. An exterior finish of two-part polyurethane or approved equal shall be provided for equipment control groups. The color shall be as approved by SFMTA.

22.23.5 Painting Restrictions

Any equipment or parts of equipment which would be damaged or suffer impaired operation from painting shall not be painted and shall be corrosion resistant. The following parts shall not be painted:

A. General Parts:
   1. Conduit and fittings
   2. Copper tubing, piping and fittings
   3. Wire and cable
   4. Power resistors
   5. Heat transfer surfaces
   6. Electrical insulators
   7. Elastomeric portions of air and refrigerant lines
   8. Grounding pads.

B. Truck-Related Items:
   1. Wheels
   2. Axles
   3. Elastomeric parts
   4. Grease fittings
   5. Linkages
   6. Threaded parts used for adjustments
   7. Electrical equipment
   8. Wearing surfaces.

22.23.6 Interior Painting

All exposed interior surfaces, including molding and trim, shall be as specified in Section 10, or powder-coated metal.

Interior surfaces requiring painting shall be coated with an approved thermosetting powder coating. Parts which are to be powder-coated shall be cleaned and prepared in accordance with the recommendations of the powder supplier.

The Contractor and its powder supplier shall supply a touch-up procedure and ensure that a continued supply of touch-up paint in the proper colors suitable for spot application will continue to be available in the United States.

22.23.7 Corrosion Protection

Concealed surfaces capable of rusting or oxidation shall be properly cleaned, receive a wash primer, then primed with a two-part epoxy paint, and painted with an approved finish coat of paint.

Where arc welding is performed on joints between stainless steel and other materials, the joint shall be de-scaled and cleaned, and then painted in accordance with Section 22.23.3.

22.23.8 Acoustical Insulation

Acoustical insulating materials shall be applied to properly cleaned underframe, sides, ends, roof and floor sheets, as required in Section 8, to the supplier's recommendations. The materials shall be resistant to dilute acids, alcohols, grease, gasoline, aliphatic oils, and vermin. The material shall be unaffected by sunlight and ozone and shall not become brittle with age. It shall be Daubert Chemical Company's No. 368 sound deadening compound, Aquaplas No. DL-10, or approved equal. The Contractor may propose an alternative insulation system. The alternative acoustic insulation system shall be service proven for commuter rail vehicle application and shall demonstrate compliance with the design and performance requirements specified.

22.23.9 Trucks

All truck components to be painted shall be given a full coat of primer prior to assembly. Following assembly, all exposed surfaces of each truck, including machined mounting surfaces not used, shall be cleaned by blowing off with compressed air and solvent-wiped to remove all dirt and grease. All truck components not listed in Section 22.23.5 shall then be sprayed with one coat of primer and one coat of an approved black truck paint (a type that will not conceal cracks that may develop in service) and air dried.

22.23.10 Paint Process Documentation

The Contractor shall prepare a paint coating and application document containing procedures for surface cleaning and preparation, priming, surfacing, and painting for the carbody and all equipment that is painted or powder coated. A detailed paint schedule showing the equipment painted, paint type and manufacturers, recommended thickness, and other pertinent information shall also be included. This document shall be submitted to and approved by the paint component manufacturer(s) before being submitted to SFMTA for review and shall be made part of the maintenance manuals.

22.24 FLAMMABILITY AND SMOKE EMISSION REQUIREMENTS

22.24.1 General

All combustible material used in the construction of the car shall satisfy the flammability and smoke emission requirements cited in Section 4.2 and NFPA 130, "Standard for Fixed Guideway Transit and Passenger Rail Systems, 2007 Edition."

22.25 SECTION DELETED

22.26 ELECTRICAL AND ELECTRONIC DESIGNS

22.26.1 Section Deleted

22.26.2 Section Deleted

22.26.3 Hardware

Refer to Section 22.2.2 for general hardware requirements. All hardware associated with electronic and electrical control systems shall be protected against moisture, oxidation, and common airborne contaminants. Hinges and latches shall be of stainless steel.

22.26.4 Wiring

Wire selection, routing and securement shall be accomplished with the goal of having the wire and cable last the life of the carbody. All movement and chafing of wire and cable shall be eliminated. The use of additional wear material(s) to extend life without elimination of the movement, wearing or chafing will not be permitted. Refer to Sections 22.16 through 22.21 for additional wire and wiring requirements.

22.26.5 Optical Fibers

Any application of optical fibers shall be approved prior to implementation. This approval is not intended to discourage the use of optical fibers. Rather, it is to verify reliability and maintainability of the proposed application. In no case shall the on-car repair of an optical fiber require sophisticated or complex polishing and alignment. The connections between optical fibers and car-replaceable units shall be via approved "quick disconnects."

22.27 SEMICONDUCTOR STANDARDS

22.27.1 General

Semiconductors shall be selected to withstand all continuous and transient voltage and power demands present in the circuit application without damage or reduction in life. All circuit designs shall provide for the presence of high current switching equipment on the vehicle and the resultant induced voltages and currents in electrical equipment.

All semiconductor devices shall be derated to operate within the acceptable region for electrical and temperature stress as specified in "Reliability Toolkit: Commercial Practices Edition." If

there is a conflict between guidelines given elsewhere in the Specification and the "Reliability Toolkit," the more restrictive condition shall govern. Other service-proven devices may be submitted for approval.

22.27.2 Ratings

Discrete semiconductors shall have the following minimum voltage breakdown ratings:

A. Semiconductors, except diodes (see below), operated from the battery supply, or those connected to trainlines, shall have minimum breakdown ratings of four times the maximum achievable circuit voltage. Suppression devices shall be provided as necessary to protect the devices and limit the circuit voltage.

B. Diodes operated from the battery supply, used as suppression devices, or connected to trainlines shall have a minimum breakdown rating (PIV) of 1,000 V. Diodes with less than 1,000 V PIV rating may be used if adequate circuit transient protection is also provided.

C. All discrete semiconductors operated from inverters or other isolating devices shall have a minimum breakdown rating of two times the maximum circuit voltage, except where specifically detailed otherwise. Suppression devices shall be provided as necessary to protect the devices and limit the circuit voltage.

All semiconductor junction temperatures shall be limited to 150°C (or to the maximum rated temperature for the device, whichever is less) or less at maximum ambient temperature and at maximum rated output power.

All semiconductors shall be operated at less than 50% of the maximum continuous current rating or 50% of the maximum continuous power rating, whichever is more restrictive. High power/current devices may be exempt from this requirement with prior approval, on a case-by-case basis. The Contractor shall submit complete device information, including all manufacturer's application recommendations, and calculated current and power demands with all waiver requests. If approved, such waivers do not reduce other requirements, including reliability.

Integrated circuits operated from the battery supply through inverters or other isolating devices shall be operated within the voltage and current ratings specified by the manufacturer, derated to less than 50% of the maximum stress level at the maximum operating temperature of the device as specified by the manufacturer.

Where the supplies to integrated circuits are regulated and surge protected, the voltage rating shall be 15% below the manufacturer's recommended maximum. In addition, the maximum power shall be limited to 50% of the manufacturer's specified maximum at the maximum operating temperature.

Silicon semiconductors shall be hermetically sealed and rated for operation over the temperature range of -40°C to +85°C. Non-hermetic devices are acceptable to SFMTA provided comparable reliability documentation is available upon request.

All Gallium Arsenide and similar optical semi-conductors shall be rated for operation over the temperature range of -40°C to +85°C.

22.27.3 Availability and JEDEC Registration

Except as approved, all semiconductor devices shall be JEDEC registered and numbered.

JEDEC registered devices with house numbers may be used only if a complete cross-reference is provided linking each house numbered device with a JEDEC registered device. House labeled devices shall be clearly labeled with the manufacturer's name or logo.

All semiconductors shall be available from at least two manufacturers and available from U.S. distributors. Single source devices, such as high voltage power devices, microprocessors, ASICs, and related support chips may be used only if approved. Such devices shall be essential to the proposed equipment, shall meet the proven service requirements, and shall be supplied by veteran manufacturers likely to support the device.

22.27.4 Other Prohibitions

Electronic equipment shall utilize stock components and shall function properly with the component manufacture's full range of tolerances such that after-purchase screening or testing of components shall not be required.

Matching of components is permitted only if the components are normally available from the manufacturer in matched sets.

Germanium semiconductors shall not be used.

22.28 PRINTED CIRCUIT BOARD STANDARDS

22.28.1 General

Printed circuit boards shall be designed, constructed and inspected to IPC-2221, latest revision, unless more stringent requirements are noted here. Traces shall be made as wide as practical, with the minimum width being based on a 10°C temperature rise. Run spacing shall conform to MIL-STD-275, latest revision.

Circuit board material shall be per MIL-P-13949, latest revision, with a minimum thickness of 1/16-inch using type GB or GH base material. Type GE material may be used for boards which have no components whose power dissipation is greater than two watts and when said board is not mounted adjacent to components dissipating greater than two watts. The copper laminate shall be firmly attached to the board and shall be resistant to blistering and peeling when heated with a soldering iron.

Components with pins shall be mounted only on one side. Connections shall be made to the other side or internal layers via plated through holes. SMT devices may be mounted on both sides if part of an approved existing design.

All circuit boards shall be inherently stiff or shall be reinforced to prevent damage due to vibration or handling. Circuit boards larger than 100 in^2 shall be centrally stiffened unless otherwise approved.

All printed circuit boards with the same function shall be interchangeable between equipment groups without additional adjustment.

All printed circuit boards shall be of the "plug-in" type, with positive support against vibration, except where approved otherwise.

Printed circuit boards shall be mounted in the vertical plane with positive retention by keeper bars unless otherwise approved. These retaining mechanisms shall be simple, easily applied/removed without tools and shall remain attached to the card rack. PCBs shall be fully inter-changeable without adjustment by the use of digital circuits, stable components, and tight tolerance components as applicable. Potentiometers shall not be permitted. All electronic control units, PCBs, major components and assemblies shall be serialized and contain a bar code label.

22.28.2 Marking

All circuit boards shall be labeled with a part number, serial number, and descriptive nomenclature.

All components shall be labeled on the board with component drawing references and such other information as may be required to repair and troubleshoot the board. The component and wiring sides of the board shall each be marked to indicate capacitor and diode polarity, and at least two leads or one lead and a graphic symbol indicating orientation of all transistors and thyristors.

Integrated circuits and other multi-terminal devices shall have an index mark on the component side of the board, visible with the component inserted, to indicate proper keying and insertion; the first pin on all IC packages shall be identified on the wiring side of the board.

For boards whose component density is greater than 2.25 components per square inch, the Contractor may submit an alternate marking plan for possible approval. Such a plan should include board marking, augmented by layout drawings.

22.28.3 Component Mounting

Components shall be fastened to the board in such a manner as to withstand repeated exposure to shock and vibration. Large components shall be supported in addition to the solder connections. Power resistors shall be mounted on standoffs so that the resistor bodies do not contact the board, spaced far enough away from the board so that resistor-produced heat will not discolor or damage the board.

22.28.4 IC and Device Sockets

IC and device sockets are prohibited except for components that must be removed for reprogramming or initial calibration procedures or devices that are available only in mounting

in sockets. All socket applications are subject to SFMTA approval. All other components shall be soldered in place.

Where approved, IC sockets shall comply with MIL-S-83502C and MIL-S-83734, as is applicable for the device, and shall be made of the following materials:

A. The bodies shall be molded from diallyl phthalate, PTFE Teflon, or approved equal.

B. The contacts shall be fabricated from beryllium copper and shall be plated with a minimum of 0.000030 inch of gold over a minimum of 0.000050 inch of low stress nickel in the area of contact with IC pins.

22.28.5 Conformal Coating

Both sides of the assembled printed circuit boards shall be coated with a clear insulating and protective coating material conforming to MIL-I-46058 latest revision, or approved equal.

The coating shall be easily removed with a brush-applied solvent or penetrated by a hot soldering iron when a component must be unsoldered. The coating solvent shall not adversely affect board mounted components.

All IC sockets, connectors, and test points shall be masked when the coating is applied.

22.28.6 Keying

All printed-circuit boards shall be "keyed" to prevent insertion into the wrong socket.

22.28.7 Circuit Board Connectors

Printed circuit board connectors shall be heavy duty, high reliability, two-part type with a history of successful service in rail applications and shall be approved by SFMTA prior to commencing design.

Connectors which comply with MIL-C-55302, latest revision, and which have plated contacts as described below, are considered to comply with the requirements of this section.

The connector contact area shall be plated with a minimum of 0.000030-inch of gold over a minimum of 0.000050-inch of low stress nickel.

All connectors within one panel assembly shall be keyed to prevent damage or malfunction due to incorrect insertion.

Refer to Section 22.16.5 for wire wrap used and connection requirements.

22.28.8 Testing

Sufficient clearance shall be provided between components to allow testing, removal and replacement without difficulty due to lack of space.

Test points shall be provided in appropriate locations on modules and printed circuit boards. A negative return test point shall also be provided. The test points shall either accept and hold a standard 0.080-inch diameter tip plug, or shall be a turret lug similar to Cambion No. 160-1026-01-05, or approved equal, with sufficient clearance to permit it to accept a standard oscilloscope probe clip, and shall be identified by appropriate markings.

22.28.9 Plated-Through Holes

In addition to the general guidelines of the Institute of Printed Circuits (IPC), the following requirements shall be met:

A. Plating Holes. Copper plate shall be a minimum of 0.001-inch minimum average thickness, and 0.003-inch maximum average thickness. Solder plates shall be 0.0003-inch minimum average thickness and 0.0015-inch maximum average thickness.

B. Plated Hole Defects. No more that than three voids per hole will be acceptable. Total area of the voids shall not exceed 10% of the total wall area. The largest void dimension shall not exceed 25% of the core diameter or the board thickness, whichever is smaller. There shall be no pits, voids or cracks at the junction of the whole wall and terminal area to a depth of 1-1/2 times the total copper thickness on the surface.

22.28.10 Multilayer Boards

Multilayer PC boards and high-density surface mount components will be permitted. To ensure repairability by SFMTA, the Contractor shall provide the following minimum documentation:

A. Assembly and detailed layout drawings.

B. Complete parts listing

C. Schematics and interconnection diagrams

D. Source control for any parts on the parts list that can not be directly ordered from an electronics catalog.

E. Theory of operation.

The Contractor may propose, for SFMTA approval, alternate methods to ensure long term maintainability of equipment.

22.28.11 Enclosures

All circuit boards that are rack mounted shall plug into racks containing the mating half of the circuit board connector. The circuit board rack shall mount in an enclosure conforming to requirements in this document. The rack, circuit board, and circuit board hardware shall be designed as an integrated system.

The rack and enclosure shall provide environmental and EMI shielding as required to meet the requirements of this document.

Printed circuit boards shall be positively retained by means of keeper bars or other approved method. The enclosure or rack cover shall not be used to retain the circuit boards.

Each circuit board shall be fitted with an ejector or hand grip to assist in board removal. The rack and the edge of each board, or the card ejector, shall be labeled with corresponding numbers to identify board location within the enclosure.

Enclosure features specified above shall be presented for approval during preliminary design and prior to commencing final design.

22.28.12 Extenders

Printed circuit board extenders (six sets of each type) shall be provided by the Contractor for test purposes. At least two extenders of each type shall be available for use and evaluation throughout the design conformance and acceptance test programs.

22.29 MICROPROCESSOR-BASED SYSTEM HARDWARE

22.29.1 Hardware Platform

Carborne and custom computer hardware shall be designed and constructed in accordance with the general electronic design principles of Section 22. The microprocessor based control systems shall be based on an established family of microprocessors in wide use in the control system industry. They shall be supported by a full range of software development languages and diagnostic programs. Any use of commercially available computer boards must be specifically approved. Such approval will be based upon a technical review of the product, product documentation, and a commercial assessment of product availability.

22.29.2 Electrical Isolation and Pre-Processing

The control system shall be powered by dedicated transformer-isolated power supplies driven from the vehicle battery circuit.

All control system input and output signals shall be through isolation buffers. High voltage inputs and outputs shall be isolated external to the microcomputer card rack. Low voltage (battery and logic voltage level) inputs and outputs shall be isolated via buffer cards in or external to the microcomputer card rack.

The isolation buffers shall:

A. Protect and isolate the control system from damage due to over-voltage, under-voltage, transients, shorts, and opens

B. Perform necessary voltage translations

C. Remove noise and undesired signals

D. Limit, pre-process, discriminate and format those signals that would otherwise require excessive processor time

E. Consist of optical isolators, transformer isolators, and other circuits appropriate to the application. Voltage divider circuits will not be allowed.

22.29.3 Section Deleted

22.29.4 Section Deleted

22.29.5 Section Deleted

22.29.6 Section Deleted

22.29.7 Section Deleted

22.30 ELECTRICAL DEVICES AND HARDWARE

22.30.1 General

All electrical devices shall be transit industry-proven.

22.30.2 Contactors and Relays

22.30.2.1 General

Unless otherwise approved, all contactors and relays shall meet or exceed the requirements of MIL-R-6106, MIL-R-5757 or IEC947-4 as applicable, with the following two qualifications:

A. Devices shall be tested for proper functioning in orientations up to 30 degrees from the orientation in which they are mounted in the vehicle, in each of the three possible rotations: pitch, yaw, and roll.

B. If adequate documentation exists demonstrating that during functional and operational testing of the vehicle the contactors underwent normal duty cycle tests, it shall be considered as an acceptable alternative to a burn-in.

C. In selected applications, contactors and relays shall comply with the requirements of MIL-R-6106 (for ratings of 10 amperes or greater) and MIL-R-5757 (for ratings of less than 10 amperes) but need not be qualified to these documents if all of the following requirements are met:

1. The device is service proven in the exact same application.
2. The device is service proven in transit service.
3. All other requirements of this Specification are met.
4. SFMTA approves of this application.

All devices shall be constructed and utilized in a fail-safe manner; that is, all failures shall be in a direction so that neither the passengers, the crew, or the equipment are placed in jeopardy.

All devices shall be installed so that they are fully accessible for inspection, repair-in-place, or removal and replacement. All contactor terminals shall be fully accessible for trouble shooting purposes.

Contactors and relays shall incorporate means of visually determining whether they are picked up or dropped out. Relays on printed circuit boards or within electronic assemblies may be exempted from the requirement for a visual indication, as approved.

Unless specifically approved on a case basis, there shall be a maximum of no more than two wire terminations on any one contact of the device.

The coils of all devices shall be suppressed to protect the low-voltage network from generated transients.

Under no circumstances shall either the main or auxiliary contact tips of the devices be placed in parallel for the purpose of carrying a current load at or above the manufacturer's contact tip rating.

Contact tip ratings shall be stated for the worst condition of reduced surface contact which may result from tip misalignment during normal operation of the device.

Contactor installation shall be such that the arc spray is directed by an arc chute away from ground and any other electrical devices proximate to the Contactor.

Devices shall be constructed in a very heavy-duty fashion suitable for use in railroad service. SFMTA reserves the right to review and approve the design and selection of all contactors and relays.

Contactor tip replacement shall not exceed 10% of the total number of tips at 90-day intervals.

All contactors shall be constructed so that the main contact tips make and break with a motion (wipe) that prevents deposits and pitting.

All contactors shall be built with series-fed blowout coils. The Contractor shall demonstrate the ability of each contactor type to reliably interrupt current over the full design operating range.

All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit designation. No identifications shall be obscured, or partially obscured, by wire routing. The identification strip shall be mounted adjacent to the mounting of said device.

Bifurcated contacts shall be used in low voltage applications, whenever necessary due to dry contacts or low current switching requirements.

All time delay relays shall be of the R-C delay or solid state type. No mechanical or pneumatic time delay devices will be permitted.

Where plug-in relays are approved, the relay shall be positively retained by means of a retaining clip or bar. This device shall be captive, of rugged construction and shall be easily positioned for relay installation and removal without the need for special tools. When the relay is removed, the retainer shall itself be retained so that it cannot come in contact with devices which may have exposed energized electrical circuits, and it shall not interfere with the operation of any other device when in this position.

Adequate gap and creepage distances shall be maintained from high voltage contactor tips and low voltage coil and auxiliary contacts to prevent entry of high voltage arcs or transients into the low voltage circuits. The same applies to grounded mounting surfaces.

Relays shall not be affected by the accumulation of airborne dust. Equipment boxes that contain relays or contactors must be ventilated to prevent ozone corrosion.

Solid State Relays shall be rated to meet the worst case environmental requirements of their installed location, meet the creepage and clearance requirements of this specification and have output stages that conform to the semiconductor requirements of Section 22.27.1 and 22.27.2.

22.30.2.2 Section Deleted

22.30.3 Switches

Under no circumstances shall poles of switches be placed in parallel in order to carry currents in excess of the contact pole rating given by the manufacturer.

Switches shall be provided with a "keying" feature so that after installation, the body of the switch is constrained from mechanical rotation.

All switches provided shall be of the highest quality procurable and shall be fully suitable for the rigors of SFMTA's service environment. The design and selection of all switches shall be subject to review and approval.

More than two wires connected to each terminal of the device shall be subject to approval Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

All control switches that are subject to water splash, which is defined to mean any switches mounted near windows or doors, or mounted on the Operator's control console, shall be environmentally sealed. Toggle and pushbutton switches shall be per MIL-S-3950, MIL-S-8805, MIL-S-83731, or equal, as approved.

All safety-critical switches, such as those that can cause door openings, shall be designed to withstand a high potential test of 1,500 volts for one second, in a clean, dry condition, without false conduction. The design and selection of all switches shall be subject to review and approval.
Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

In addition to the above requirements, all switches and pushbuttons shall meet the following requirements:

A. Contact resistance shall be less than 0.1 ohm at 3 VDC and a 10 milliamp load.
B. Open circuit resistance shall be 50 meg-ohms minimum.
C. Resistance to case shall be 1000 meg-ohms minimum at 500 VDC.

22.30.4 Circuit Breakers

22.30.4.1 General

All circuit breakers provided shall be rugged and fully suitable for the service intended.

They shall be of the highest quality procurable. Design and selection of all circuit breakers shall be subject to review and approval.

All circuit breakers of the same rating shall be of the same manufacture and model throughout the vehicle.

The ON, OFF, and TRIPPED positions of all circuit breakers shall be permanently marked on the handle or the case of the circuit breaker. The circuit breaker, when tripped, shall assume a distinct position between the ON and OFF positions to permit determination of the fact that it has been tripped by either its overcurrent or shunt trip elements.

All circuit breakers shall be mounted in the vertical direction with the ON position up.

Circuit breakers shall be individually replaceable without disconnecting or removing anything other than a faceplate, the mounting fasteners, and electrical connections of the breaker to be replaced.

Electrical connections to circuit breakers shall either be threaded to accept machine screws or use a threaded stud. Wires to circuit breakers shall use ring terminals.

Circuit breaker terminals shall not be used as junction points.

Each and every input power circuit shall be protected by an individual circuit breaker. Separate circuit breakers shall be provided for major assemblies or functions. No circuit breaker shall protect more than one circuit, nor shall any one circuit be protected by more than one circuit breaker.

All circuit breakers shall be sized by current rating and tripping time to protect both the associated equipment and the minimum size wire used for power distribution within the protected circuit without causing nuisance tripping.

High voltage circuit breaker poles may be connected in series if necessary to achieve the stated voltage interruption requirements.

Each circuit breaker pole shall be equipped with adequate means of arc extinction to prevent flashover.

The continuous current rating of thermal-magnetic trip circuit breakers shall be selected in accordance with ANSI C37.16 for the load and type of service specified.

All thermal-magnetic trip circuit breakers shall conform to the requirements of ANSI C37.13 and IEEE C37.14.

Circuit breaker current rating shall be clearly and permanently marked and shall be completely visible after installation.

Electrically operated circuit breakers shall be arranged for operation from the low voltage DC supply.

22.30.4.2 High-Voltage Circuit Breakers

All DC high voltage circuit breakers shall be three-phase AC medium voltage devices with not less than 3 poles connected in series.

All distribution-type, high voltage circuit breakers shall be Westinghouse Series C, FDB frame, Heinemann type GH, or approved equal.

The trip elements shall be thermal-magnetic, or magnetic, connected in series.

The circuit breaker handle shall protrude from the circuit breaker panel cover sufficiently to be manipulable in all positions.

22.30.4.3 Low-Voltage Circuit Breakers

Low voltage circuit breakers shall be either one-pole or two-pole devices depending on the intended function. Trip elements shall be thermal-magnetic, or magnetic, as is appropriate for the application.

All low voltage circuit breakers shall be:

A. General Use. Westinghouse Series C, Quicklag C frame, or approved equal, front connection or approved access arrangement, and approved labeling

B. Fast Operation. Airpax type IMLK, dust sealed, magnetic breaker, or Airpax type UP, hermetically sealed, magnetic breaker, or an approved equal.

22.30.5 Fuses

Fuses may be used only where specifically called for in this Specification or where the use of circuit breakers is not technically feasible, and only with specific approval. Fuses may be considered in applications as follows:

A. To protect solid state equipment from catastrophic damage
B. Where current or voltage levels prohibit circuit breakers

Fuses shall be used in car heater circuits only with the approval of SFMTA.

Fuses shall be permanently identified adjacent to the fuse. The rating of each fuse shall be permanently and clearly marked directly on each fuse.

Fuses shall be readily accessible. All fuses mounted in exterior equipment boxes shall be accessible without going under the vehicle.

Fuse holders shall contain fuse retention devices at both ends.

Air gap and creepage distances shall be as approved. Fuses used in nominal 750 volt circuits shall be rated for no less than 1,000 volts.

High voltage fuses shall be mounted in totally enclosed, dead front, fuseholders, with no exposed high voltage connections. The fuse shall be extracted from the circuit when the fuse holder is opened and the exposed fuse shall be safely isolated from any circuit connection.

Unless explicitly noted otherwise in this Specification, all fuse compartments shall have a spare fuse of identical size and rating for each "in-circuit" fuse, and shall be mounted next to the respective "in-circuit" fuse with the fuse holder clearly marked SPARE FUSE. The spare fuse holder shall not be enclosed and shall not consist of any loose parts.

22.30.6 Bus Bars

Bus bars are to be fabricated from OFE (Oxygen Free Electronic CDA 10100) or ETP (Electrolytic Tough Pitch CDA 10100) copper. The bus bar conductivity shall be 100% IACS. All bus bar joints shall be silver or tin plated.

Current densities, other than at joints, shall not exceed 1,575 amperes per square inch, and in any case shall not exceed a value which would cause a bus bar temperature rise greater than 30°C. Current densities in joints shall not exceed 600 amperes per square inch.

Bus bars shall be properly brazed together at joints unless bolted connections are found to be absolutely necessary for maintenance purposes and are approved. The overlap at busbar joints shall be no less than 10 times the thickness of the bus material. Bus bar connection bolts shall be torqued to obtain a uniform bus bar connection pressure of 200 psi. Bolting hardware shall be plated steel with belleville washers to maintain connection pressure.

Except for connection areas, bus bars shall be safety-insulated, using a high-dielectric, powder coating or other approved means. Tape is not acceptable. Bus bars that are behind insulating panels, and those cases where there are suitable warning labels and maintenance procedures that prohibit opening the equipment case when energized, are exempt from this requirement.

22.30.7 Capacitors and Resistors

Hermetically sealed, dry tantalum capacitors, in metal cases, shall be used in place of aluminum electrolytics, except for very high values which are not commercially practical or available, in which case long life grade aluminum electrolytics shall be used.

Commutating capacitors shall be a paper or plastic film type, shall incorporate a non-toxic impregnant, and shall be chosen to give a service life of at least 20 years. Filter capacitors shall have high ripple current rating for long life.

Capacitors shall be derated 20% for voltage based on the nominal supply voltage and maximum case temperature. If filter capacitors are exposed to low ripple voltages, lesser values of derating may be accepted if it can be shown that reduced operating temperatures can be achieved due to lower dissipation; however, the sum of the DC and AC ripple voltages shall always be less than the capacitor's voltage rating at a maximum case temperature of 85°C.

Except for braking power resistors, all resistors shall be derated 50% for power dissipation. Other power resistor applications may be submitted for approval of lower derating, on a case-by-case basis.

22.30.8 Transformers and Inductors

Transformers and inductors shall be derated 10% for current.

Transformers shall:

A. Have vacuum-impregnated windings.

B. Be rated to withstand at least twice the maximum peak-to-peak voltage that they shall be subjected to in operation.

C. Not emit audible noise in excess of 60 dB referenced to 20 micropascals at a distance of 2 feet (0.61 m) while operating at rated voltage and load. Not emit audible noise in excess of 60 dB referenced to 20 micropascals at a distance of 2 feet (0.61 m) while operating at rated voltage and load.

D. Be designed to minimize radiated and induced EMI.

E. The location, orientation, mounting, cable connections and cable routing shall be in accordance to the overall EMI/EMC control plan for the vehicle.

22.30.9 Switch, Circuit Breaker and Fuse Panels

All switch, circuit breaker and fuse panels shall be dead front types mounted in the specified equipment enclosures.

Each switch and circuit breaker panel shall carry the necessary apparatus, arranged to be easily accessible to connections and designed to prevent operating or maintenance personnel from coming in contact with live parts when operating the switches or circuit breakers. Furthermore, all live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.

All switches, breakers, fuses, and indicating lights shall be provided with a nameplate of raised or recessed lettering on the dead front, clearly identifying the circuit which each controls and its circuit designation. The dead front panel shall conform to NFPA No. 70, Article 384. The dead fronts shall be made of moisture-proof, electrically insulating, laminated phenolic or fiberglass, of approved quality suitable for switchboards. Asbestos shall not be used.

A wiring gutter shall be provided along the top, sides and bottom, for the routing of high voltage leads to their designated circuit breakers.

The panel shall be secured by approved, captive fasteners and shall be configured for easy removal so that maintenance and repair action is not impeded.

Power distribution to circuit breakers and switches shall be from a bus bar or bus circuit. Distributing power by successive or "daisy-chained" connections between device terminals will not be permitted.

22.30.10 Battery Backup Circuits

Where individual electronic circuits require their own battery, the following conditions apply:

A. Batteries shall be rechargeable nickel-cadmium , or nickel metal hydride, with a built-in charger or non-rechargeable lithium, unless otherwise approved.

B. Batteries shall be easily replaceable, and must not be soldered in place.

C. If a nickel-cadmium , or nickel metal hydride battery is used, the charge time vs. discharge time must be approved, for the specific application. In no case shall the battery life-span be less than 5 years.

D. If a lithium battery is used, the calculated life-span and the assumptions for that calculation must be approved for the specific application. In no case shall the life span be less than 5 years.

E. In order to properly assess the impact of distributed battery backup systems, the Contractor shall provide a complete list of battery locations, battery type, estimated lifespan, discharge time, and the impact of battery discharge failure. Approvals of items above may be affected by this total vehicle evaluation.

22.30.11 Section Deleted

22.31 SECTION DELETED

22.33 REFERENCED STANDARDS

AA	Aluminum Association - Aluminum Standards and Data
AA	Aluminum Association - Engineering Data for Aluminum Structures
AA	Aluminum Association - Specification for Aluminum Structures
AALA	American Association of Laboratory Accreditation
AAR	Specifications for the Construction of New Passenger Equipment Cars
AAR	Manual of Standards Section F S-538, Wiring Practice and Rolling Stock Standard
AAR 2518	Standard S-400
AAR M-101	Axles, Carbon Steel, Heat Treated

AAR M-107/208	Wheels, Carbon Steel
AAR M-201	Steel Castings
AAR M-601	Hose, Wrapped, Air Brake, End Hose
AAR M-618	Hose Air, Wire Reinforced
AAR M-620	Hose Air, Fabric Reinforced
AAR M-927	Hose Fittings and Hose Assemblies, Air, Wire Reinforced
AAR RP-585	Wire and Cable Specification
AAR RP-589	Rating for Specific Fuel Consumption of Diesel Electric Locomotives
AAR S-503	Fuel Additive Evaluation Procedure
AATCC Test 16A	Colorfastness
ALCOA Tech. Rpt 524	Specification Covering Use of Aluminum in Passenger Carrying Railway Vehicles
AMS-W-6858	Resistance Welding - Nickel & Cobalt Base Alloys.
ANSI B1.1	Unified Inch Screw Threads
ANSI B1.13M	Metric Screw Threads – M Profile
ANSI B16.18	Cast Copper Alloy Solder Joint Pressure Fitting
ANSI B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
ANSI B18.1.2	Large Rivets
ANSI B-20.1	Safety Standard for Conveyors and Related Equipment
ANSI B31.1	Code for Pressure Piping
ANSI C37.13	Low Voltage AC Power Circuit Breakers Used in Enclosures
ANSI C37.16	Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors Preferred Ratings, Related Requirements, and Application Recommendations
ANSI C80.1	Rigid Steel Conduit - Zinc Coated
ANSI Z26.1	American National Standard for Safety Glazing Materials for Glazing Motor Vehicles and Motor Vehicle Equipment Operating on Land Highways – Safety Code
ANSI/ASTM E94	Standard Guide for Radiographic Examination
ANSI/IEEE 730	Standard for Software Quality Assurance Plans
ANSI/IEEE 1016	Recommended Practice for Software Design Description
APTA SS-C&S-004	Standard for Austenitic Stainless Steel for Railroad Passenger Equipment

APTA SS-M-012-99	Standard for the Manufacture for Wrought Steel Wheels for Passenger Cars and Locomotives
ASME	Boiler and Pressure Vessel Code for Unfired Pressure Vessels
ASME FAP-1-1990	Quality Assurance Program for Fastener Manufacturers and Distributors
ASTM A6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A176	Standard Specification for Stainless and Heat Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A262	Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
ASTM A275/275M	Standard Test Method for Magnetic Particle Examination of Steel Forgings
ASTM A480	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A488/488M	Standard Practice for Steel Castings, Welding, Qualifications of Procedures and Personnel
ASTM A502	Steel Structural Rivets
ASTM A504	Specification for Wrought Carbon Steel Wheels
ASTM A568	Standard Specification for General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled
ASTM A588	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 Mpa] Minimum Yield Point to 4-in. [100 mm] Thick
ASTM A606	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A666	Standard Specification for Annealed or Cold-Worked Austenitic Steel Sheet, Strip Plate, and Flat Bar
ASTM A668A/668M	Specification for Steel Forgings, Carbon and Alloy for General Industrial Use

ASTM A710	Standard Specification for Age-Hardening Low-Carbon Nickel-Copper-Chromium-Molybdenum-Columbium Alloy Structural Steel Plates
ASTM A729	Specification for Alloy Steel Axles, Heat-Treated, for Mass Transit and Electric Railway Service
ASTM A736A	Standard Specification for Pressure Vessel Plates, Low-Carbon Age-Hardening Nickel-Copper-Chromium-Molybdenum-Columbian and Nickel-Copper-Manganese-Molybdenum
ASTM A763	Standard Practices for Detecting Susceptibility to Intergranular Attack in Ferritic Stainless Steels
ASTM A788	Standard Specification of Steel Forgings, General Requirements
ASTM A966/966M	Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B32	Standard Specification for Solder Metal
ASTM B33	Standard Specification of Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM B85	Standard Specification for Aluminum-Alloy Die Castings
ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B172	Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors
ASTM B174	Standard Specification for Bunch-Stranded Copper Conductors for Electrical Conductors
ASTM B221B/221M	Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
ASTM B247	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM B280	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B298	Standard Specification for Silver-Coated Soft or Annealed Copper Wire
ASTM B633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C273	Standard Test Method for Shear Properties in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores

ASTM C297	Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions
ASTM C365	Standard Test Method for Flatwise Compressive Properties of Sandwich Cores
ASTM C393	Standard Test Method for Core Shear Properties of Sandwich Construction by Beam Flexure
ASTM C542	Standard Specification for Lock-Strip Washers
ASTM D256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension
ASTM D470	Standard Test Methods for Cross-linked Insulations and Jackets for Wire and Cable
ASTM D573	Standard Test Method for Rubber – Deterioration in an Air Oven
ASTM D618	Standard Practice for Conditioning Plastics for Testing
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D673	Mar Resistance of Plastics
ASTM D695	Standard Test Method for Compressive Properties of Rigid Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D785	Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials
ASTM D952	Standard Test Method for Bond or Cohesive Strength of Sheet Plastics and Electrical Insulating Materials
ASTM D1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
ASTM D1055	Standard Specification for Flexible Cellular Materials – Latex Foam)
ASTM D1149	Standard Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber

ASTM D1499	Standard Practice Filtered Open-Flame Carbon-Arc Type Exposures of Plastic
ASTM D2261	Standard Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure
ASTM D2584	Standard Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D2671	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ASTM D2724	Standard Test Methods for Bonded, Fused, and Laminated Apparel Fabrics
ASTM D3159	Standard Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials
ASTM D3182	Standard Practice for Rubber – Materials, Equipment and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
ASTM D3183	Standard Practice for Rubber – Preparation of Pieces for Test Purposes from Products
ASTM D3190	Standard Test Method for Rubber – Evaluation of Chloroprene Rubber (CR)
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test
ASTM D3574	Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
ASTM D3597	Specification for Woven Upholstery Fabrics
ASTM D3675	Standard Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source
ASTM D3775	Test Method for Warp End Count and Filling Pick Count of Woven Fabric
ASTM D3776	Standard Test Method for Mass Per Unit Area (Weight) of Fabric
ASTM D 4034	Test Method for Resistance to Yarn Slippage at the Sewn Seam in Woven Upholstery Fabrics
ASTM D4541	Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D4966	Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Method)
ASTM D5402	Standard Practice for Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs
ASTM D 5034	Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)

ASTM D5420	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight
ASTM D5628	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimens by Means of a Falling Dart (Tup or Falling Mass)
ASTM E94	Standard Guide for Radiographic Examination
ASTM E119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E162	Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
ASTM E446	Standard Reference Radiographs for Steel Castings Up to 2 in. (5 mm) in Thickness
ASTM E662	Standard Test Method for Specific Optical Density of Smoke Generated by Solid
ASTM E648	Standard Test Method for Critical Radiant Flux of Floor-Covering Systems using a Radiant Heat Energy Source
ASTM E709	Standard Guide for Magnetic Particle Examination
ASTM E1354	Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
ASTM F519	Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments
ASTM F606	Standard Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets
ASTM F1344	Standard Specification for Rubber Floor Tiles
ASTM G23	Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
AWS	Welding Handbook
AWS A2.4	Standard Symbols for Welding, Brazing, Nondestructive Examination
AWS B2.2	Brazing Procedure and Performance Qualification
AWS D1.1	Structural Welding Code, Steel
AWS D1.2	Structural Welding Code, Aluminum
AWS D1.3	Structural Welding Code, Sheet Steel

AWS D1.6	Structural Welding Code - Stainless Steel
BSS-7239	Boeing Specification Standard
DIN 43 650A	Standards for Pins, Rivets, Keys, Adjusting and Retaining Rings
FAA Spec AC 43.13-1	Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair
Fed Spec QQ-B-654	Brazing Alloys, Silver
Federal Spec. TT-P-38	Paint, Aluminum, Ready
Federal Spec WW-T-799	Tube, Copper, Seamless (Use with Solder-Flared/CMPRS)
FRA 49CFR Part 223	Safety Glazing Standards – Locomotives, Passenger Cars and Cabooses
ICEA S-19-81	Rubber-Insulated Wire and Cable for the Transmission
ICEA S-66-524	Cross-Linked-Thermosetting-Polyethylene-Insulated
ICEA S-95-658	Non-Shielded Power Cables Rated 2000 V or Less
IEC 947-4	Low-Voltage Switchgear and Control Gear, Part 4: Contactors and Motor-Starters
IEEE-383	Class 1e Electric Cables, Field Splices, & Conn.
IEEE C37.14	Low-Voltage DC Power Circuit Breakers
IPC 2221	General Guidelines
ISO 2553	Welded, Brazed and Solder Joints Symbolic Representation on Drawings
ISO 4400	Fluid Power Systems and Components – Three-Pin Electrical Plug Connectors With Earth Contact – Characteristics and Requirements
JIS Z 3021	Symbolic representation of welds
MIL-C-5015	Connectors, Electric, Circular Threaded, AN Type, General Specification for
MIL-C-7438	Core Material, Aluminum, for Sandwich Construction
MIL-C-13777	Cable, Special Purpose, Electrical
MIL-C-27072	Cable, Power, Electrical and Cable, Special Purpose Electrical, Multi-conductor and Single Shielded
MIL-C-55302	Connectors, Printed Circuit Subassembly and Accessories
MIL-HDBK-132	Protective Finishes - For Metal and Wood Surfaces
MIL-HBK-217	Reliability Prediction for Electronic Systems
MIL-HBK 338	Electronic Reliability Design Handbook

MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies
MIL-M-81531	Marking of Electrical Insulating Materials
MIL-P-13949	Plastic Sheet, Laminated Metal Clad (For Printed Wiring Boards)
MIL-P-23469	Pin-Rivet, Grooved and Collar, Grooved Pin-Rivet, Swage-Locked (Lockpin)
MIL-PRF-6106:	Relays, Electromagnetic (TP15.31.2.1)
MIL-R-5757	Relays, Electromagnetic
MIL-S-3950	Switches, Toggle, Environmentally Sealed
MIL-S-8805	Switches and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for
MIL-S-83502	Socket, Plug-In Electronic Components Round Style
MIL-S-83731	Switches, Toggle, Unsealed and Sealed Toggle, General Specification For
MIL-S-83734	Sockets, Plug-In Electronic Components, Dual-In-Line Packages (Dips) and Single in Line Packages (Sips), General Specification for
MIL-T-6845	Tubing, Steel, Corrosion-Resistant (530400), Aerospace Vehicle Hydraulic System 1/8 Hard Condition
MIL-T-7928	Terminal, Lug Splices, Conductors, Crimp Style, Copper
MIL-T-8504	Tubing, Steel, Corrosion-Resistant (304), Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-T-16366	Terminals, Electrical Lug and Conductor Splices, Crimp Style
MIL-T-55164	Terminal Boards, Molded, Barrier, Screw and Stud
MIL-W-16878	Wire, Electrical, Solderless Wrap, Insulated, and Uninsulated
MIL-W-22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
MIL-W-81822	Wire, Electrical, Solderless Wrap, Insulated, and Uninsulated
MIL-STD-410	Qualification and Certification of Inspection Personnel in the European Aerospace Industry
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-275	Printed Wiring for Electronic Equipment

MIL-STD-25036	Terminal, Lug, Crimp Style, Copper, Insulated, Ring Tongue, Bell Mouthed, Type II, Class 1 (for 105 Degrees C Total Conductor Temperature)
NASM 21044	Nut, Self-Locking, Hexagon, Regular Height, 250 Degrees F, 125 KSI and 60 KSI
NBS PS 1-95	Construction and Industrial
NEMA LD-3	High-Pressure Decorative Laminates
NEMA STD 250	Enclosures for Electrical Equipment
NEMA WC3	Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC70	Cross Linked Thermosetting Polyethylene Insulated Wire and Cable for Transmission and Distribution of Electric Energy
NEMA WC 27500	Standard for Aerospace and Industrial Cable
NFPA 70	National Electric Code
NFPA 130	Fixed Guideway Transit and Passenger Rail Systems
SAE J343	Tests and Procedures for SAE 100R Series Hydraulic Hose and Hose Assemblies
SAE J356	Hose Clamps
SAE J516	Hydraulic Hose Fittings
SAE J517	Hydraulic Hose
SAE J524	Seamless Low Carbon Steel Tubing Annealed for Bending and Flaring
SAE J533	Flares for Tubing
SAE J1273	Selection, Installation, and Maintenance of Hose and Hose Assemblies
SAE J1405	Flex-Impulse Test Procedures for Hydraulic Hose Assemblies
SMP-800C	Toxic Gas Generation
UL-6	Electrical Rigid Metal Conduit - Steel

appendix **twenty-three**

Light Rail Vehicle DVAS Technical Specifications

Revision History

Revision	Date	Change	Approval
0	12/04/2009	Release for RFQ/RFP	n/a

Appendix 23
Light Rail Vehicle Digital Visual and Audio System Upgrade
Technical Provisions

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San Francisco Municipal Transportation Agency

Light Rail Vehicle Digital Visual and Audio System

Contract 1240: Radio System Replacement Project - Technical Provisions

1 INTRODUCTION

The Light Rail Vehicle Digital Visual and Audio System shall be implemented for San Francisco Municipal Transportation Agency's (SFMTA) (151) Light Rail Vehicles (LRVs). Currently a digital voice annunciation system exists on SFMTA LRVs, and the rubber-tired fleet. On the LRVs, this system is available in the Advanced Train Control System's (ATCS) territory underground, when the train operates in ATCS auto mode. As part of this system, the function of the existing digital voice annunciation system on the LRVs shall be upgraded as specified within this document. The Contractor shall design, develop, install, integrate, test, and make operational all equipment associated with the DVAS, and provide equipment warranty support. The Contractor shall provide all equipment, assemblies, mountings, wiring, cabling, hardware, software, special tools, diagnostic equipment, spare parts, training to SFMTA staff, and training manuals as identified in these documents. The Contractor shall also ensure that the DVAS interfaces and functions as intended with the existing, and future equipment to be procured by the SFMTA. The Contractor shall interface the Digital Visual and Audio System with the equipment procured under the Muni Radio System Replacement (MRSR) Project.

The DVAS shall announce audio messages to passengers and concurrently shall also display messages on internal passenger facing signs as specified in this document. As part of its function, the DVAS shall also control the destination signs, run number signs, and interfaces to transfer and activate data/voice/audio on trailing cars. The DVAS shall also interface with a Wireless Bulk Data Transfer Subsystem furnished as part of the MRSR, and shall function as specified in these documents. The SFMTA shall be able to add, change, and delete both audio and visual messages using the Contractor supplied software and hardware. The new equipment shall interface with the existing on-board equipment and also the equipment to be procured in the future as part of the MRSR Project.

All vehicles shall be equipped with identical and exchangeable DVAS equipment to achieve the intended functions. The DVAS shall interface with the following existing and the planned new vehicle-borne equipment under the MRSR Project including but not limited to:

- Microphone
- The coupling/uncoupling trainlines
- Current radio system and future radio system
- Passenger doors
- Existing LonWorks network
- Internal and external speakers
- Destination signs
- Run number signs

2 BACKGROUND

The SFMTA operates the San Francisco Municipal Railway ("Muni"), which is the seventh largest public transit system in the United States. SFMTA has approximately 700,000 riders on an average weekday. Its fleet of about 1,000 vehicles, over half of which are electric, consists of subway-surface light-rail vehicles (Metro streetcars), electric trolley buses, diesel buses, the world-famous cable cars, and a unique collection of historic streetcars. The first publicly owned streetcar system in a major city in the U.S., Muni has been serving the people of San Francisco since 1912. More information about SFMTA can be obtained at http://www.SFMTA.com.

Currently, SFMTA operates two sets of LRVs, LRV2s, and LRV3s, supplied by AnsaldoBreda in conjunction with the Advanced Train Control System (ATCS) equipment supplied by Alcatel Transport Inc. (now Thales Rail Signaling Solutions, Inc). Currently, all of SFMTA's LRVs are equipped with an internal Digital Voice Annunciation System which functions only in the ATCS territory, when the vehicle operates in auto mode. Currently no provisions exist for automatic announcements in street running territory, and there are no passenger information on-board signs that could display the next stop or other information. To improve passenger information, SFMTA is planning to replace the existing Digital Voice Annunciation System with a new DVAS which shall announce the stations within the subway regardless whether vehicles operate in ATCS auto or cutout modes, as well as in the street running operations. Additionally, the system shall also automatically display messages on the internal signs of the vehicles in accordance with the ADA requirements. The DVAS shall also control the destination and run number signs to display destination and run number based on the parameters entered by the operator.

3 ABBREVIATIONS AND DEFINITIONS

Where any word or phrase defined below, or a pronoun used in place thereof, is used in any part of the contract documents, it shall have the meaning set forth herein.

ADA: Americans with Disability Act

ATCS: Advanced Train Control System

Automatic Vehicle Location (AVL): A subsystem of DVAS where all active components to determine vehicle location are installed and operating on-board. This applies to both street running and subway operations.

CCP: Communications Control Panel.

Consist: A group of coupled LRVs which make up a train.

DMS: Digital Visual and Audio System Management System

Download, Data: To transfer data from the yard installed Wireless Bulk Data Transfer Subsystem to LRV or LRVs.

DVAS: Digital Visual and Audio System. A current existing system on-board the LRVs is also known by this abbreviation, but is spelled as Digital Voice Annunciation System.

Log-on: The act of activating the DVAS functions and interfaces and entering the required parameters.

Log-off: The act of deactivating the DVAS functions and interfaces.

Logover: The process of maintaining all parameters in the DVAS after key-off or key-down.

LRV: Light Rail Vehicle, also known as a Car or a Vehicle.

Internal signs: Passenger facing electronic signs installed within the interiors of the LRVs to display passenger information.

Route Pattern: A Route Pattern carries the following information: destination, stop/station sequence, and supporting data such as distance between stops/stations, stop/station location; and any other information required by the DVAS.

Train: Consist of up to four LRVs

Trainline: Communication link crossing the coupler

Upload, Data: To transfer data from the LRV or LRVs to the Wireless Bulk Data Transfer Subsystem.

4 EXISTING LIGHT RAIL VEHICLES AND ON-BOARD SYSTEMS

The LRVs are equipped with the following elements or subsystems:

- Carbody
- Operator's Cab
- Propulsion
- Friction brakes
- Doors
- Steps
- Communications
- Couplers
- Auxiliary electric
- Air comfort

The LRVs are bi-directional, electrically propelled via overhead contact wires and pantograph interface, and with a fully functional operator's cab at each end. The cars are designed to run in up to four vehicle consists, and the LRV DVAS system shall be able to operate all functions in such a configuration. When coupled, the trainline signals are transmitted from one vehicle to another which provides the control of the entire consist from either end. When uncoupled, each vehicle operates independently. The carbody is divided into two sections, section A with the pantograph on the roof, and section B without pantograph. Currently there are no spare trainlines for the Contractor's use.

The on-board communications system includes the following:

a. Operator/Passenger audio subsystem
b. Cab-to-cab audio subsystem
c. Radio Communications Subsystem

The Operator/Passenger Audio Subsystem consists of the following equipment:

- Communications Control Panel (CCP), two (2) per vehicle
- Gooseneck Microphone, two (2) per vehicle
- Communications Amplifier and Control Unit (CACU), one (1) per vehicle in the A cab
- Passenger Intercom Unit (PIU, two (2) per vehicle
- Interior Speakers, eight (8) per vehicle
- Exterior Speakers, two (2) per vehicle

The Radio Communications Subsystem includes:

- Radio Set, for vehicles 1400 through 1476, one (1) per vehicle located in the A end cab; for vehicles 1477 through 1550, two (2) per vehicle
- Radio power supplies, coinciding and adequate for the number of radios.
- Mobile Communication Terminal, two (2) per vehicle
- Radio Silent Alarm Switch, two (2) per vehicle
- Radio Antennas

Function of the key elements of the communications system is as follows:

a. Cab-to-Cab Voice Communications – Enables two way voice communications between any active and inactive cab.

b. Passenger Intercom – Enables passengers to communicate with the operator.

c. Public Address (PA) – Allows one-way voice announcements from energized cab to all vehicles in the train or consist. As part of the PA function, train controllers can make announcements via mobile radio on a train or a consist, when the operator selects Radio/PA mode. The PA is also used to broadcast within a train a chime or tone signal to alert passengers that doors are being closed. In addition, the PA interfaces with the ATCS equipment to broadcast automatic announcements within the subway. Currently, announcements by central control, received through the mobile radio, have the highest priority, followed by ATCS triggered announcements and last, vehicle operator announcements.

d. Radio – Allows the train operator to communicate with the Central Control dispatcher and maintenance personnel. The train radio also transmits a train-operator initiated "silent alarm".

In the current configuration, the ATCS driven audio signal is provided to the CACU, which drives the speakers. The operator controls this unit through the CCP located at each end of the vehicle. The LRVs are also equipped with outward facing run and destination signs, which are controlled by an existing LonWorks Control Panel located at each end and are communicated through the vehicle trainlines, using the existing LonWorks network.

Currently the LRVs are equipped with one Digital Voice Annunciation System unit located in the "A" cab. The Digital Voice Annunciation is the interface

between the CACU and the Vehicle On Board Computer (VOBC). It is powered through the vehicle's low voltage supply of 37.5 VDC, and shall be replaced.

SFMTA shall make all the available drawings and manuals available to the Contractor for reference. SFMTA does not guarantee the accuracy or completeness of these documents. The Contractor shall verify the accuracy of these documents and shall direct any issues, questions, comments to SFMTA in writing.

The Contractor shall ensure that the equipment installed under the Awarded Contract shall have adequate and Approved EMI/RFI mitigation measures through shielding, grounding and other Approved means. The mitigation efforts shall be employed for emissions/interferences including, but not be limited to radiated emissions, conductive emissions, inductive emissions, and radio frequency/wireless interferences. As part of the Awarded Contract, the Contractor shall identify power needs, conduit needs, and other needs of the system being provided.

Existing equipment and waste removed during the installation shall be decommissioned and disposed in accordance with the requirements of Appendix 12, section 1.

5 PRE-PROPOSAL VEHICLE INSPECTIONS

The SFMTA will make one sample vehicle available for the Qualified Proposers' inspections as part of the pre-proposal conference only. This shall be an opportunity for the QualifedProposers to review the vehicles, space available, wiring/cabling prior to submitting their proposals. The sample vehicle will only be a typical representative of the fleet. SFMTA does not assure that all vehicles have identical configurations, and the Qualified Proposers are encouraged to not assume that to be the case. Any issues noticed by the Proposers during this pre-proposal inspection shall be reported to SFMTA in writing. Based on the complexity of the issue, SFMTA may release an Addendum to the RFP, if necessary.

6 DIGITAL VISUAL AND AUDIO SYSTEM (DVAS)

6.1 General

The Contractor shall supply all equipment and shall install and test a fully functional Digital Visual and Audio System (DVAS), even if the specific equipment, parts, hardware, software, or assemblies are not specified within this RFP. The objective of this system shall be to improve passenger information and to comply with the requirements of the ADA. The DVAS shall also control the destination and run number signs.

The Contractor shall provide a vehicle test setup of the equipment installed within the operator's cab, including a quantity of (1) of each visual and audio component installed as part of the DVAS, connected to the vehicle test setup.

When installing the fleet, the Contractor shall include adding controls, warning audio/visual alarms within the cab to meet the needs of the DVAS. However, the equipment shall not interfere with operating functions and the equipment shall not interfere or block the view of the operator's field of vision.

The DVAS shall comply with all applicable standards, regulations, codes, laws, and requirements whether identified herein or not. To the maximum extent possible, the Contractor shall utilize the existing equipment such as cabling, conduits, speakers, microphones, handsets, mounts, brackets, and assemblies. In SFMTA's opinion the current speakers and conduits can be utilized. However, the SFMTA cannot assure that all the equipment is in working order or fit for the application, and the Contractor shall verify and record the availability and function of existing equipment. Based on this verification, the Contractor shall reuse or replace the existing equipment. As part of their proposal, the Qualifed Proposers shall include a budget for the replacement of existing equipment.

The Contractor is encouraged to submit alternate designs if such designs may benefit SFMTA. SFMTA shall have the latitude to choose any design or technology which is deemed most beneficial to SFMTA. The following is a sample list of equipment and does not necessarily imply any specific technology. The use of active wayside components such as signposts, hub odometers, or obsolete technologies such as LORAN-C or inductive loops are not acceptable. The DVAS shall include, but shall not be limited to the following:

- Automatic Vehicle Location (AVL) equipment needed to sufficiently drive the automatic passenger information functions
- Wireless Bulk Data Transfer equipment (vehicle-borne and at fixed side at yards)
- Operator Control Unit (OCU)
- DVAS Logic and Control Unit
- Audio Pre-amplifier
- Audio Amplifier
- On-board message signs
- Memory
- Wiring, Cabling, and Support Mounts
- Software and firmware
- On-board computers, routers, access points, modems
- Wireless bulk data transfer equipment at yards

- Manuals, training material, system administration, diagnosis and analysis tools, and test equipment
- Any interfacing equipment for the integration with the ATCS, if needed

Single points of failures shall be minimized in the DVAS. In an event the DVAS Logic and Control Unit fails, the vehicle operator shall still be able to make manual announcements over the PA and the passenger activated "Stop Request" in the internal sign shall remain functional, destination signs shall also remain functional.

The Contractor shall provide all data to achieve functions identified herein including, but not limited to basic data, schedules as needed, audio recordings, initial parameter sets, on-board sign messages, and OCU display texts. All data as part of the Awarded Contract shall remain or become the property of SFMTA and the Contractor shall have no rights on any supplied or generated data associated with the Awarded Contract.

The Contractor shall ensure that the available power shall be used for powering the new and existing equipment. The power utilization scheme shall be submitted by the Contractor for review and approval as part of the design report.

6.2 Functional Requirements

The SFMTA LRVs operate in both street running operations and within subway tunnels. The existing Digital Voice Annunciation System relies on input from the ATCS for automatic announcements. The DVAS shall use on-board AVL, which shall be based either on one technology such as DGPS, or a combination of technologies such as, for example, DGPS and RFID. Location information is also available from the ATCS when vehicles operate in the ATCS territory. On-board AVL to drive DVAS and all other functions shall be provided regardless whether trains are operating in auto, or cut-out mode.

Upon key-on, the MDT shall prompt and enable the operator to input the following information:

- Enter Operator ID (badge number)
- Select Route pattern
- Enter Run number

This may include additional data elements, depending on the design of the MTMS. These inputs shall not be lost upon key-down. In addition to these inputs, the MDT shall also enable the following functions:

- Manual overrides to set destination signs selectable on the entire train or consist and on a per-car basis
- Manual triggering of pre-defined announcements
- Operator logover, to keep the selected route pattern and run at operator relieve
- Pre-departure self test and diagnostics
- Log off

During operations, the DVAS shall announce the following:

- Next stop/station message, when the LRV leaves a stop/station at a distance configured by SFMTA
- Stop approaching message, when the LRV is approaching a stop/station at a distance configured by SFMTA
- Left or right side where doors open. Note: LRVs can be run with the A or B section forward. The DVAS system shall correctly determine which side the doors open, in relation to the direction of travel.
- On the external speakers: Route and destination when doors are open at a stop/station. These shall be played at the side where the vehicle doors open.
- Other public service messages, as defined by SFMTA
- Warning message of steps movement (up or down)
- Door closing
- The operator triggered messages based on the input from the MDT

The internal sign shall display the following:

- Next stop/station name following departure at the previous stop/station
- Route and destination when the vehicle is stopped with doors open at a stop/station
- Other public service messages, as defined by SFMTA
- Operator ID (badge number) with a SFMTA configurable text message
- Current time
- Message corresponding to the operator triggered annunciation

Using the Digital Visual and Audio System Management System (DMS), the SFMTA shall be able to add, delete, modify, change, edit all audio and visual messages. This data shall be downloaded to the vehicle via the wireless bulk data transfer subsystem. Each SFMTA defined audio and visual message shall be controlled by an SFMTA defined start and end date and time. SFMTA shall also be able to define repetition intervals for each of the SFMTA defined automatic audio and visual messages.

The DVAS shall announce audio messages via the existing, or replaced, internal and external speakers on the LRVs. Two separate ambient noise sensor mechanisms shall control the audio volume levels to the internal and external speakers. The SFMTA shall also be able to control the external and internal volume levels through software configuration that is downloaded to the fleet as part of the wireless bulk data transfer. SFMTA shall have the capability to define audio levels on a vehicle by vehicle basis, overriding the global default volume level. When set at any level, the ambient noise sensor shall pick up noise levels from interiors and exteriors as applicable and shall be able to adjust the output levels accordingly. The DVAS shall have an automatic time-based volume output level controller for both interior and exterior PA. This time-based volume output controller shall be independent from the ambient noise sensors. In the event of a conflict between the output levels between the ambient noise sensors and output level controls, the time-based volume output controller shall have a higher priority and shall override the ambient noise sensing. Once the time-based volume output controller is set to control noise levels on specific days and specific times, operator intervention to change announcement volume levels shall not be required and not allowed. The time-based volume output control data, shall be downloaded to the fleet through the Wireless Bulk Data Transfer Subsystem.

The passenger next stop request signal shall be used as input to light up a visual sign that may be integrated in the internal sign, and that shall replace the next stop request signs currently installed on board of the LRVs. The stop request indicator shall be based on LED technology. Activation and clearing of the replacement stop request sign shall replicate the existing sign's logic.

When LRVs are coupled, the DVAS of the leading car shall control the function for the entire consist. When uncoupled, each vehicle based DVAS shall function independently.

The signs, background colors, text size and fonts shall be compliant with ADA requirements and shall be Approved by SFMTA. The DVAS shall include manual vehicle operator overrides for on-board signs to clear existing messages and manually set new messages. The selection process as presented to the vehicle operator shall be simple, via push-buttons, and the message selection shall be self explanatory via menu-driven or similar Approved method.

The DVAS shall replace the existing amplifier unit. This shall include all necessary pre-amplifiers, and amplifiers, and shall have the exact same output levels throughout the fleet, regardless whether vehicles are coupled, or not. The current power amplifier unit key data is known as follows:

- Supply voltage: +37.5 VDC
- Output: 70.7 Vrms, with 250 ohm load
- Frequency response: ± 1 db., 200 to 5000 Hz. At 70.7 Vrms
- Distortion: Less than 1%, 250 ohm load, 200 to 5000 Hz

Further details, including the circuit diagrams of the communications system will be made available by SFMTA to the Contractor. The SFMTA cannot guarantee the accuracy or correctness of the data provided. It shall be the Contractor's responsibility to verify all output voltages, power levels, and any other data.

6.3 On-board Sign and PA Requirements

The Contractor shall supply four (4) new internal signs for each LRV and four (4) new stop request signs, which may be included in the new internal signs. The placement and use of single and double-sided signs shall be such that passengers on board of the vehicle can see and read the internal signs.

The Contractor shall design the system such that the existing CCP can be eliminated, as part of the radio system replacement. When two or more vehicles are coupled, the PA audio related control signals shall be transmitted via the existing LonWorks network to the trailing vehicle. The control signal shall enable the trailing LRV to play the exact same message as played in the lead car. The process shall not introduce perceivable delays. The messages played on the PA in the leading and trailing cars shall be at the same time.

In coupled consists, the on-board signs shall be interfaced with the existing LonWorks network. The existing LonWorks network controller shall control all destination, run number, on-board signs in the leading and the trailing cars. The DVAS shall have adequate memory to include all of SFMTA's existing stops/stations, plus the capacity of adding 100% more stops/stations by SFMTA using the Wireless Bulk Data Transfer. The memory shall be commercially available from at least 3 different suppliers and shall be expandable by SFMTA to add total 200% plus the original number of stops.

6.4 Fallback Levels

In an event that the DVAS Logic Unit either fails completely or partially, or in case it is removed, or is not functioning, or is inoperable due to failing internal/external interfaces, the DVAS shall revert to fallback level operation. The DVAS shall also include a manual override function, which when activated shall result into fallback level. While the DVAS is in the fallback level, the following functions shall be available without the DVAS Logic Unit:

- Operator PA announcements
- Next stop request including the sign and audible signal
- Door closing tone
- Destination signs through the existing LonWorks Control Unit
- Passenger intercom
- Cab-to-cab intercom

When the DVAS Logic Unit (VLU) is either replaced, repaired, or begins to function normally, the Unit shall revert to normal level unless the system is forced into fallback level by manual override.

6.5 Data Provisioning and Management

The data provisioning and management shall be integrated and included in the data management of the MTMS. The following types of data shall be included and integrated:

- Trapeze transit data import for stops/stations, route patterns, destinations
- Management of multiple datasets with activation dates
- Management of vehicles: Selectively and globally enable and disable announcements and signage
- Validation of datasets to assure proper function of the DVAS
- Backfill of relevant data which is not part of Trapeze import such as vehicle lists, system parameters
- Access to software status and data load reports
- Staging of data download and software updates
- Managing of data upload
- Management of recording and internal sign functions
- Pre-departure vehicle status report
- Wireless bulk data transfer subsystem status report
- Automatic vehicle location and announcement and electronic signage trigger reporting

This is not an all inclusive list.

7 INTERNAL AND EXTERNAL INTERFACES

7.1 Wireless Bulk Data Transfer Subsystem

Data provisioning and offload shall be included and integrated with the wireless bulk data transfer subsystem that will be installed with the MTMS.

7.2 Visual and Audio Recording and Development Environment

As part of the Awarded Contract the Contractor shall supply a completely functional audio recording and on-board sign message development environment.

The environment shall include, but shall not be limited to the following:

- Recording equipment including microphones, workstation with monitor

The vehicle test setup shall be utilized to test recordings and internal sign messages, including:

- Test sign(s) which represent the current configuration of vehicle installed internal signs
- Test speaker(s) which represent the current configuration of internal and external speakers
- Wires, cables, harnesses
- Fully functional VLU and MDT
- DVAS Logic and Control Unit
- Wireless Bulk Data Transfer subsystem equipment

The vehicle test setup shall be integrated in a portable enclosure. It shall be capable of performing the functions of the DVAS.

The SFMTA shall be able to create, record, change, modify, update the audio and service messages and shall be able to download them to the vehicles. The download process shall be a simple select, click and download type process and shall not take more than 15 minutes to update all data to a vehicle. The upload process from the LRV to the Wireless Bulk Data Transfer server shall not take more time.

In the test and analysis environment, the Contractor shall provide a tool that allows SFMTA to visualize and analyze the vehicle location performance and triggering of announcements and electronic signage, and, as a result, to confirm proper function of the DVAS, or to troubleshoot defects reported from the field. This tool shall put SFMTA in a position to determine root causes of non conforming announcement and electronic signage, such as AVL problems, inaccurate data or insufficient operator training.

The Contractor shall submit for SFMTA Approval the design of the Visual and Audio Recording and Development Environment, including narrative, drawings, datasheets, and product specifications.

7.3 Vehicle Local Area Network and Wireless Interface

The Contractor shall provide a Vehicle Local Area Wireless Network Interface as required in Appendix 12, section 3.2.4.

The Contractor shall submit for SFMTA Approval the design of the Vehicle Local Area Network and Wireless Interface, including narrative, drawings, datasheets, and product specifications.

8 INSTALLATION

Material and Workmanship standards are listed in Appendix 22.

9 TESTING

As part of the Awarded Contract, the Contractor shall initiate, develop, and conduct a comprehensive test program to test the DVAS. General Test Program Requirements are listed in Appendix 12 Section 7.

The entire LRV DVAS test program shall be documented in details in the Testing Plan which shall be submitted by the Contractor for SFMTA's review and Approval. The Plan shall include all details necessary for informing SFMTA about the Contractor's testing process, repair/replacement, documentation control related to testing, and any other relevant information.

The testing process shall be divided into following categories:

a. Factory Testing For Vehicle-Borne Equipment
b. Factory Testing For fixed side Equipment
c. Static Vehicle-Borne Equipment Testing
d. Dynamic Vehicle-Borne Equipment Yard Testing
e. Dynamic Vehicle-Borne Equipment Revenue Service Testing
f. Fixed side Equipment Testing
g. System Integration Testing
h. Vehicle logs and diagnosis environment to confirm the proper function or to identify defects in AVL and on-board passenger information functions
i. Other Testing

This is a minimal list and does not necessarily include all types of tests. It is the Contractor's responsibility to include all necessary tests to ensure a complete functional system as identified within this specification. SFMTA reserves the right to request additional information, additional tests, or other information as necessary. The Contractor shall provide all tools, equipment, labor and technical personnel to perform and complete all test.

a. Factory Testing For Vehicle-Borne Equipment

This category shall include all tests conducted by the equipment designer, supplier, vendor in their factory on the vehicle-borne hardware, software, firmware, and other equipment. The SFMTA at its discretion may witness these tests. These tests shall follow the Quality Control/Quality Assurance program. Upon successful completion of the factory testing, the Contractor shall issue either a Certification of Successful Test Completion, or test results clearly show that the test has passed successfully. These documents shall be submitted to SFMTA for review and Approval.

b. Factory Testing For Fixed Side Equipment

This category shall include all tests conducted by the equipment designer, supplier, vendor in their factory on the fixed side hardware, software, firmware, and other equipment. The SFMTA at its discretion may witness these tests. These tests shall be conducted at assembly level and shall follow the Quality Control/Quality Assurance program. Upon successful completion of the factory testing, the Contractor shall issue an either Certification of Successful Test Completion or test results clearly stating that the test has passed successfully. For Common-Of-The-Shelf (COTS) commercially available equipment such as servers, operating systems, this test shall not be necessary. However, if the COTS equipment is interfaced with other equipment, then the test results or certificates are required. These documents shall be submitted to SFMTA for review and Approval.

c. Static Vehicle-Borne Equipment Testing

The Contractor shall conduct static vehicle-borne equipment testing on SFMTA's facilities. The testing shall include verification of function of all vehicle-borne equipment identified in the functional requirements. During this static testing, the vehicle shall remain stationary. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

d. Dynamic Vehicle-Borne Equipment Yard Testing

The SFMTA shall permit the Contractor's use of their test track within the Muni Metro East (MME) facility for a limited number of hours to be confirmed by SFMTA. The Contractor shall setup the equipment around this test track to conduct the DVAS testing within the yard. This shall include the testing of all requirements of the DVAS. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test

shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

e. Dynamic Vehicle-Borne Equipment Revenue Service Testing

The Contractor shall test the vehicle-borne equipment in revenue service during SFMTA authorized hours. The objective of this test shall be to verify that the equipment functions correctly in revenue service. This test shall include single vehicle testing, coupled (in all combinations) vehicle testing, coupling/uncoupling, on-board sign functions, PA function, stop requested function, fallback level, and all other functional requirements identified in this specifications. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests.

f. Fixed Side Equipment Testing

The Contractor shall plan and conduct the fixed side equipment testing. This shall include, but shall not be limited to, the Wireless Bulk Data Transfer Subsystem, visual and audio recording and development environment, all hardware, software, firmware, and equipment. The testing shall include creating messages, transmitting messages over the SFMTA network, storing messages at the maintenance facilities, data upload/download to the vehicles, simulated failures, power loss, and other functions of the DVAS. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. The SFMTA at its discretion may witness these tests, and this test shall be conducted at the SFMTA's facilities.

g. System Integration Testing

The Contractor shall plan and conduct a comprehensive system integration test. The objective of this test shall include, but shall not be limited to verifying and validating the entire DVAS and all fixed side equipment concurrently in its entirety, against the requirements of this specification. The test shall be conducted to demonstrate that the equipment functions as specified in actual revenue service, maintenance, and the operations environment of SFMTA. At its discretion, SFMTA may attend this test. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval. This test shall be conducted on Muni's LRV routes.

h. Other Testing

The Contractor shall also conduct other tests on both the vehicle-borne and fixed side, hardware, software and firmware equipment. These tests shall include, but shall not be limited to Megger tests, Continuity Tests, Electromagnetic Interference Tests. At its discretion, SFMTA may attend these tests. All test results shall be documented and in an event of failure, the test shall be stopped, the problem shall be corrected, and the test shall resume. All test results shall be signed by the appropriate staff and the results shall be submitted to SFMTA for review and Approval.

Any deficiencies, problems, issues noticed during the testing process as a result of design, defective equipment, defective hardware, incompatible software, shall be immediately corrected by the Contractor and the test shall continue until successfully completed. Based on the nature of corrective action, the SFMTA may request the Contractor to repeat the entire test.

These are minimum requirements. The Contractor shall include additional items and topics as necessary to provide all information to SFMTA to demonstrate the DVAS meets the requirements of this specification. The SFMTA reserves the right to request additional information if needed.

After the Test Program is completed, the Contractor and SFMTA jointly shall ensure that the vehicle is returned to the SFMTA without damage, wiring problems, or missing equipment. It shall be the Contractor's responsibility to verify and report in writing any equipment missing from the vehicles prior to the equipment installation.

appendix **twenty-four**

Portable Subscriber Units

appendix has been deleted

appendix **twenty-five**

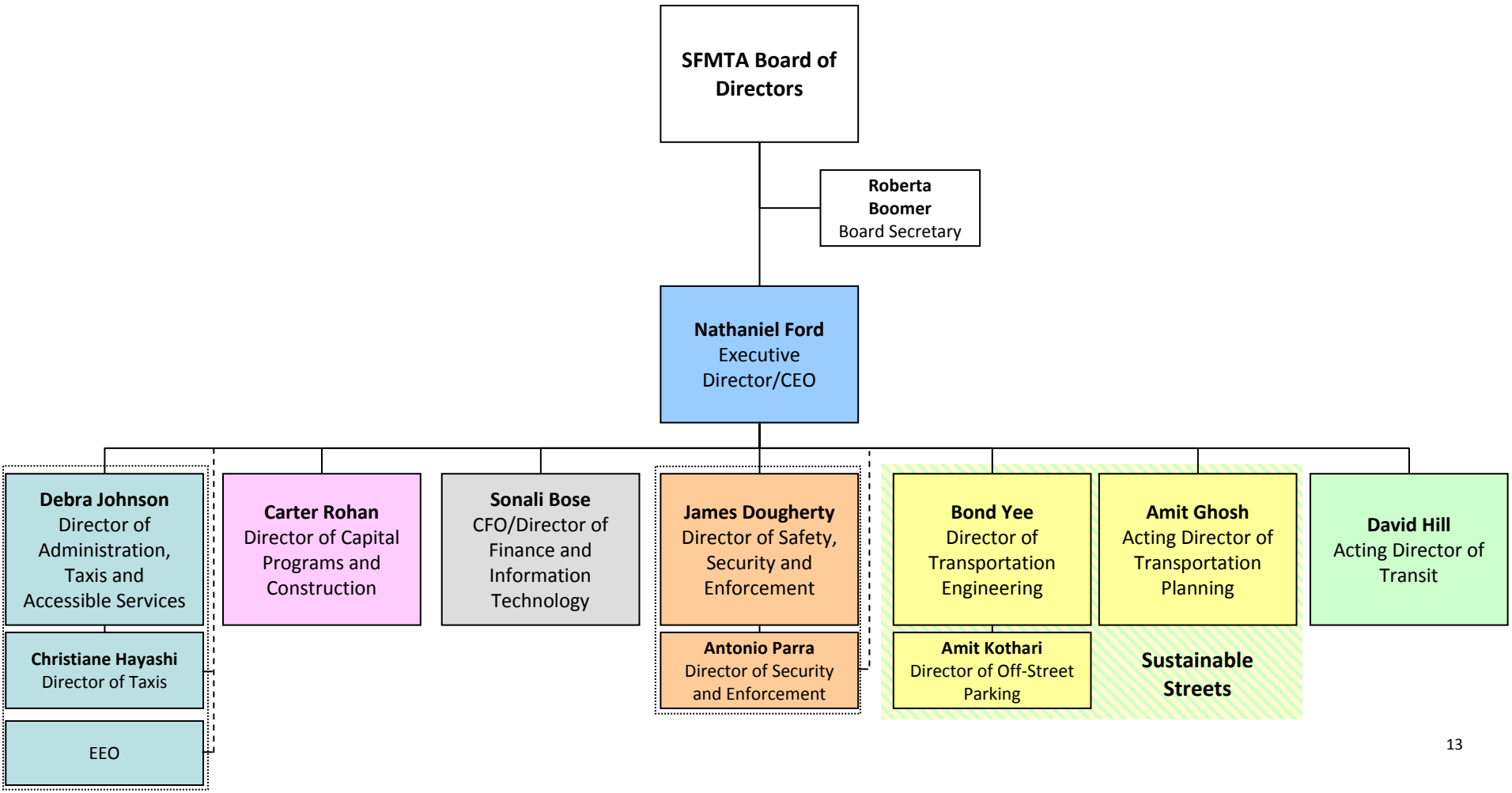
SFMTA Organization Chart

for reference only

SFMTA Organization Chart

PHASE 1

effective 9/21/09



appendix **twenty-five**

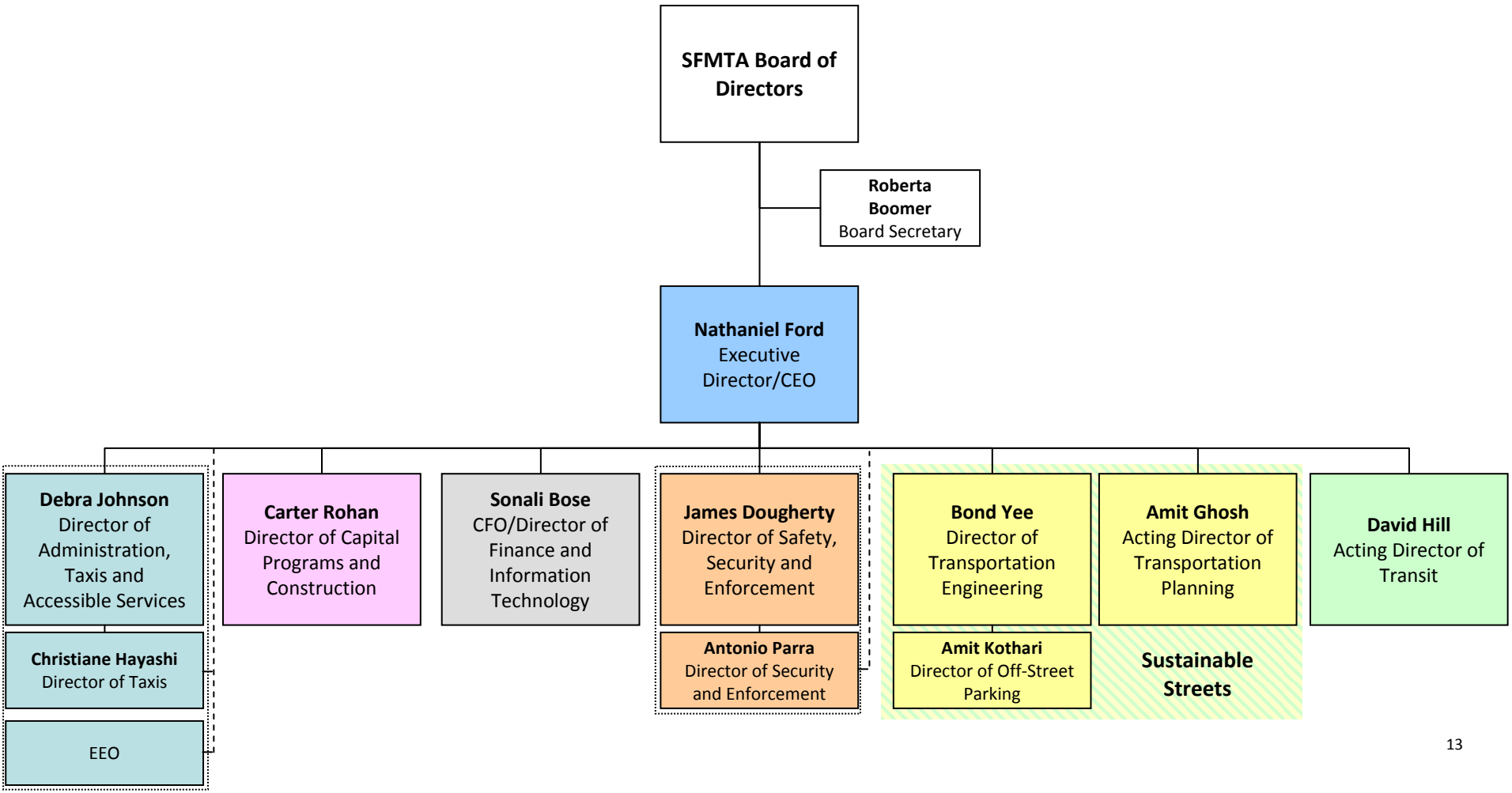
SFMTA Organization Chart

for reference only

SFMTA Organization Chart

PHASE 1

effective 9/21/09



appendix **twenty-six**

Codes & Standards

for reference only

Revision History

Revision	Date	Change	Approval
0	12/04/2009	Release for RFQ/RFP	n/a

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Introduction

This document lists the codes and standards applicable to the Radio System Replacement Project. The codes and standards are divided into the following categories and is related to design, construction and installation as applicable:

- Civil and electrical
- Communications and information technology
- Intelligent Transportation Systems (ITS)
- Other.

Reference Documents

[1] Interface Control Document for Onboard Devices and the TransLink® Driver Console, Version 0.3

[2] MTC 511 regional real-time transit system XML DTDS for JMS implementation

Civil and Electrical

The following codes, industrial standards and regulations apply to the design and construction of the surface and underground facilities:

1. State of California, Public Utilities and Commission:
   a) General Order No. 95 Rules for Overhead Electric Line Construction
   b) General Order No. 128 Construction of Underground Electric Supply and Communications Systems
   c) General Order No. 143B Safety Rules and Regulations Governing Light-Rail Transit
2. National Electrical Code (NEC)
3. The Institute of Electrical and Electronics Engineer, Inc. (IEEE)
4. City and County of San Francisco Electrical Code
5. American Society for Testing and Materials (ASTM)
6. National Electrical Manufactures Association (NEMA)
7. American National Standards Institute (ANSI)
8. Underwriter's Laboratories, incorporated (UL)

9. City of San Francisco, Department of Public Works, Bureau of Engineering Standard Specifications
10. American Concrete Institute (ACI)
11. Insulated Cable Engineers Association (ICEA) S-66-524
12. Safety-Cal/OSHA
13. San Francisco Building Code
14. American Institute of Steel Construction
15. San Francisco Traffic Code
16. American Railway Engineering and Maintenance Association (AREMA).

OSI Model Standards & Protocols

Layer		Misc. examples	IP suite	SS7[5]	OSI suite	IPX suite	SNA	UMTS
#	Name							
5	Session	Named Pipes, NetBIOS, SAP, Half Duplex, Full Duplex,Simplex, SDP	Sockets. Session establishment in TCP. SIP. (Not a separate layer with standardized API.),RTP		ISO/IEC 8327, X.225, ISO/IEC 9548-1, X.235	NWLink	DLC ?	
4	Transport	NBF	TCP, UDP, SCTP		ISO/IEC 8073, TP0, TP1, TP2, TP3, TP4 (X.224), ISO/IEC 8602, X.234	SPX		
3	Network	NBF, Q.931, IS-IS	IP, IPsec, ICMP, IGMP	SCCP,MTP	ISO/IEC 8208, X.25(PLP), ISO/IEC 8878,X.223, ISO/IEC 8473-1,CLNP X.233.	IPX		RRC (Radio Resource Control)Packet Data Convergence Protocol (PDCP) and BMC(Broadcast/Multicast Control)

2	Data Link	802.3 (Ethernet), 802.11a/b/g/n MAC/LLC, 802.1Q (VLAN),ATM, HDP, FDDI, Fibre Channel, Frame Relay, HDLC, ISL,PPP, Q.921, Token Ring, CDP, ARP (maps layer 3 to layer 2 address)	OSPF, PPP, SLIP, PPTP, L2TP	MTP,Q.710	ISO/IEC 7666, X.25(LAPB), Token Bus, X.222, ISO/IEC 8802-2LLC Type 1 and 2	IEEE 802.3framing,Ethernet II framing	SDLC	LLC (Logical Link Control),MAC (Media Access Control)
1	Physical	RS-232, V.35, V.34, I.430, I.431, T1, E1, 10BASE-T,100BASE-TX, POTS, SONET, SDH, DSL, 802.11a/b/g/n PHY		MTP,Q.710	X.25 (X.21bis, EIA/TIA-232, EIA/TIA-449, EIA-530, G.703)		Twinax	UMTS L1 (UMTS Physical Layer)

VoIP Standards

Signaling	
H.323	H.323
Megaco H.248	Gateway Control Protocol
MGCP	Media Gateway Control Protocol
RVP over IP	Remote Voice Protocol Over IP Specification
SAPv2	Session Announcement Protocol
SGCP	Simple Gateway Control Protocol
SIP	Session Initiation Protocol
Skinny	Skinny Client Control Protocol (Cisco)
Media	
DVB	Digital Video Broadcasting
H.261	Video stream for transport using the real-time transport
H.263	Bitstream in the Real-time Transport Protocol
RTCP	RTP Control protocol
RTP	Real-Time Transport
H.323 Protocols Suite	
H.225	Covers narrow-band visual telephone services
H.225 Annex G	
H.225E	
H.235	Security and authentication
H.323SET	
H.245	Negotiates channel usage and capabilities
H.450.1	Series defines Supplementary Services for H.323
H.450.2	Call Transfer supplementary service for H.323
H.450.3	Call diversion supplementary service for H.323
H.450.4	Call Hold supplementary service
H.450.5	Call Park supplementary service
H.450.6	Call Waiting supplementary service
H.450.7	Message Waiting Indication supplementary service
H.450.8	Calling Party Name Presentation supplementary service
H.450.9	Completion of Calls to Busy Subscribers supplementary service
H.450.10	Call Offer supplementary service
H.450.11	Call Intrusion supplementary service
H.450.12	ANF-CMN supplementary service
RAS	Manages registration, admission, status
T.38	IP-based fax service maps
T.125	Multipoint Communication Service Protocol (MCS).
SIP Protocols	
MIME	
SDP	Session Description Protocol
SIP	Session Initiation Protocol

APCO P-25 Standards

Please refer to Appendix L of the *Radio System Alternatives Analysis Report* for the list of applicable APCO Project 25 standards.

Intelligent Transportation Systems (ITS)

Relationship of ITS Architecture to Standards

The National ITS Architecture provides a mapping of architecture flows to individual ITS standards. Since the architecture flows of the National ITS Architecture form the basis for information exchanges of statewide or regional ITS architectures, this mapping of interfaces to standards is available for these architectures as well.

ITS standards address the interfaces between ITS systems. These interfaces and the information flows between the interfaces are identified in the regional ITS architecture. Based on the identified data flow and interfaces, the regional ITS architecture indicates what standards may be applicable. The regional ITS architecture list of applicable ITS standards is not directly applicable to specific ITS projects, but is rather a starting point for further project analysis.

Selection of Applicable National ITS Standards

The following standards are identified as those that are relevant to this project:

Table 1 – Relevant Standards to the Project from the National ITS Architecture

ITS Standard	Applicable Architecture Flow
APTA TCIP-S-001 3.0.0: Standard for Transit Communications Interface Profiles	transit vehicle location data transit vehicle schedule performance transit vehicle operator information transit fare coordination transit fare information alarm notification alarm acknowledge personal transit information transit traveler information transit traveler information coordination transit information user request transit schedule information transit vehicle loading data
IEEE IM: Incident Management Standards	transit emergency data incident response status
NTCIP C2C: NTCIP Center-to-Center Standards	transit fare coordination transit emergency data incident response status transit traveler information coordination
ITE TMDD: Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)	incident response status
ATIS General Use: Advanced Traveler Information Systems (ATIS) General Use Standards	transit fare information personal transit information transit traveler information transit information user request
NTCIP C2F: NTCIP Center-to-Field Standards	signal control status signal control data
NTCIP 1201: Global Object Definitions	signal control status signal control data

NTCIP 1202: Object Definitions for Actuated Traffic Signal Controller (ASC) Units	**signal control status** **signal control data**
NTCIP 1210: Field Management Stations (FMS) – Part 1: Object Definitions for Signal System Masters	**signal control status** **signal control data**
NTCIP 1211: Object Definitions for Signal Control and Prioritization (SCP)	**signal control data**

Additional information including descriptions and status updates about these standards is available at the ITS Joint Programs Office Standards Website (http://www.standards.its.dot.gov)

ITS Standards Related Considerations

APTA TCIP-S-001 3.0.0: Standard for Transit Communications Interface Profiles

Description: Transit Communications Interface Profiles allows for transit devices, systems, and subsystems to exchange information.

Applicability to Project: The APTA TCIP standard is insufficiently mature for implementation.

Justification: This standard has only been available for a year and a half, has not been tested to show that the standard is useful or will perform as expected in the field, nor are there vendors that have implemented the standard in their product.

IEEE IM: Incident Management Standards

Description: The IEEE IM standards provides a comprehensive and consistent message set for emergency management amongst stakeholders.

Applicability to Project: These standards will be used if used regionally.

Justification: Due to the need to communicate with other regional agencies, the project will use the regional standard for transit emergency data and incident response status.

NTCIP C2C: NTCIP Center-to-Center Standards

Description: The C2C standards provide the protocols, objects, data elements, and messages necessary to exchange information between a transportation management center, the ITS field devices it manages, and other centers.

Applicability to Project: At the applications level, XML is being considered for the project in which case **NTCIP 230**6 - Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML) will be consulted. At the transport level TCP/IP will be used according to **NTCIP 2202** - Internet (TCP/IP and UDP/IP) Transport Profile. At the subnetwork level NTCIP 2104 - Ethernet Subnetwork Profile will be used.

Justification: Due to the recent publication of NTCIP 2306 as a standard, it has not been tested nor are test guides available for the standard, guidance from the ITS JPO may be needed for implementation.

ITE TMDD: Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC)

Description: The TMDD and MS/ETMCC standards contains data elements for roadway links and for incidents and traffic-disruptive roadway events

Applicability to Project: These standards will be used if used regionally.

Justification: Due to the need to communicate with other regional agencies, the project will use the regional standard for transit emergency data and incident response status.

ATIS General Use: Advanced Traveler Information Systems (ATIS) General Use Standards

Description: A basic message set using the data elements from the ATIS data dictionary needed by potential information service providers to deploy ATIS services and to provide the basis for future interoperability of ATIS devices.

Applicability to Project: ATIS messages will be used for transit fare information, personal transit information, transit traveler information, transit information user request where existing legacy messages are not already defined within SFMTA and the region.

Justification: Some messages for exchanging transit fare information, personal transit information, and transit traveler information are already defined in existing regional standards such as MTC 511 which will take precedence. Additionally, messages used in the legacy ITS systems may need to be carried over to the new system.

NTCIP C2F: NTCIP Center-to-Field Standards, , NTCIP 1201: Global Object Definitions, NTCIP 1202: Object Definitions for Actuated Traffic Signal Controller (ASC) Units, NTCIP 1210: Field Management Stations (FMS) – Part 1: Object Definitions for Signal System Masters, NTCIP 1211: Object Definitions for Signal Control and Prioritization (SCP)

Description: The NTCIP C2F standards and associated object definitions provide the protocols, objects, data elements, and messages necessary to exchange information between a transportation management center and one or multiple field devices managed by that center.

Applicability to Project: The C2F standards apply to the signal control status and signal control data architecture flows of the MRSR project, which are already defined in the SFMTA SFgo project.

Justification: The MRSR will use the existing SFgo specifications for the signal control status and signal control data.

SAE 1708: Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications and SAE J1939 Series: Recommended Practice for a Serial Control and Communications Vehicle Network

Description: The SAE 1708 and 1939 standards guide design of systems in heavy-vehicles that have bi-directional, serial communication link among modules containing microcomputers. The standards defines the interface requirements and connecting devices necessary for the transmission of signals and information among electronic components in trucks and buses.

Applicability to Project: SAE 1708 and SAE 1939 series will be used for on-board communications to the extent possible, where new systems are specified and not limited by legacy equipment.

Justification: SAE 1708 and the SAE 1939 series have been implemented in other transit agencies and has resulted in reduction in procurement costs and facilitate system expansion and technological upgrade.

On-board systems

The onboard systems shall be designed using components that have interfaces that are fully documented and, based on a standard that is recognized by a standards-making body such as IEEE, ANSI, EIA, SAE, and ITU-T. If a proprietary interface is used it shall be fully documented and available to SFMTA for current and future system integration. The following standards apply to the design and implementation of the onboard ITS systems:

- SAE J1939
- SAE J1708
- SAE J1587
- SAE 1455 (humidity, vibration)
- NEMA IEC Enclosure 13 (IP54)
- EIA-485
- EIA-232
- IEEE 802.3
- IEEE 802.11
- IEEE 802.11i-2004
- File Transfer Protocol (FTP)
- Interface Control Document for Onboard Devices and TransLink® Driver Console (OASIS).

Other Codes, Standards and Guidelines

The following list includes the applicable standards and guidelines that do not fit in the categories above:

Muni Project Operations Manual (POM) Construction Division.

Drawings shall be submitted in AutoCAD version 2003

Project working documents shall be exchanged in Microsoft Office 2003, Microsoft Visio 2003 and Microsoft Project 2003.

FTA QA/QC guidelines[1] - http://www.fta.dot.gov/printer_friendly/publications_3876.html

Glossary of Standards Acronyms

APC – Automatic Passenger Counting

API – Application Programming Interface

ATCS – Automatic Train Control System

AVL – Automatic Vehicle Location

BCD – Binary Coded Decimal

CAD – Computer Aided Dispatch

CASR – Computer Aided Service Restoration

CCTV – Closed Circuit Television

CER – Conceptual Engineering Report

COTS – Commercial off the Shelf

DC – Driver Console

DT – Department of Technology

DSL – Digital Subscriber Line

DTD – Document Type Defintion

DTIS – Department of Technology and Information Systems

DMZ – Demilitarized Zone

DGPS – Differential Global Positioning System

DVAS – Digital Vehicle Announcement System

[1] The project Quality Assurance Plan follows the FTA QA/QC guidelines.

EA – Emergency Alarm

ECM – Electronic Control Module

FTA – Federal Transit Administration

ICD – Interface Control Document

INS – Inertial Navigation System

IP – Internet Protocol

ISSI – Inter RF Subsystem Interface

IT – Information Technology

ITS – Intelligent Transportation Systems

LAN – Local Area Network

LRV – Light Rail Vehicle

MDT – Mobile Data Terminal

MOU – Memorandum of Understanding

MRSR – Muni Radio System Replacement

MTC – Metropolitan Transportation Commission

NEMA – National Electrical Manufacturers Association

NTD – National Transit Database

OCC – Operations Control Center

OCD – Operational Concept Document

QA – Quality Assurance

QC – Quality Control

PA – Public Address

PBX – Private Branch Extension

PDS – Platform Signs

PRTT – Priority Request to Talk

PSTN – Public Switched Telephone Network

P25 – Project 25

RFP – Request for Proposal

RTT – Request to Talk

QoS – Quality of Service

SAE-J* - Society of Automotive Engineers J standards (e.g. J1708)

SAN – Storage Area Network

SCADA – Supervisory Control And Data Acquisition

SFMTA – San Francisco Municipal Transportation Agency

SLA – Service Level Agreement

SNMP – Simple Network Management Protocol

TEP – Transit Effectiveness Project

TSP – Traffic Signal Priority

Telco – Telecommunications Provider

UTA – Urban Transportation Associates, Inc.

VHM – Vehicle Health Monitoring

VMS – Variable Message Sign

VOBC – Vehicle On-Board Computer

VoIP – Voice over IP

VAN – Vehicle Area Network

VPN – Virtual Private Network

VLU – Vehicle Logic Unit

WAN – Wide Area Network

XML – Extensible Markup Language

appendix **twenty-seven**

San Francisco City Permit Process

for reference only

Gavin Newsom | Mayor
Tom Nolan | Chairman
Rev. Dr. James McCray Jr. | Vice-Chairman
Cameron Beach | Director
Shirley Breyer Black | Director
Malcolm Heinicke | Director
Jerry Lee | Director
Bruce Oka | Director
Nathaniel P. Ford Sr. | Executive Director/CEO

Permit Process

Permits shall be acquired for the proposed work prior to construction at each site. The proposed construction drawings and documents shall be stamped, signed and submitted for review by the respective jurisdiction's planning department, building department, fire department and other relevant agencies are required prior to approval of the permit application.

The purpose of the plan review process is to ensure that the proposed construction work meets planning/zoning, life safety, accessibility, structural safety, mechanical and electrical requirements of the code. Typically, the planning department reviews the plans to ensure that planning/zoning regulations are met prior to review by other agencies for building, fire, mechanical, electrical and other requirements. The planning process may require public notification and hearings involving owners and residents of the surrounding area adjacent to the site.

In the City and County of San Francisco, a pre-application process can be explored to determine the major requirements of the proposed project without the need for a full set of working plans and occurs before the application for a permit. The pre-application application will also minimize complications in the subsequent permit process by establishing policies, procedures and requirements for the project. The procedures for the pre-application process are laid out in Administrative Bulletin AB-028 of the 2007 San Francisco Building Code.

The agencies reviewing the proposed construction drawings and documents may issue comments. The comments will need to be addressed to the satisfaction of each agency at each stage of the permit process. Each jurisdiction has procedures in place that will determine if the project will be reviewed in serial or parallel with other agencies. Parallel review will generally ensure a more efficient review and approval of the project. Once all comments have been addressed satisfactorily a special inspection and structural observation form shall be completed by the Engineer of Record and approved by the building department; a permit will be issued when the fees have been paid.

The following websites contain additional information regarding the permit process for the City and County of San Francisco and City of Daly City, respectively:

www.sfdbi.org
www.sfgov.org/site/planning_index.asp
www.ci.daly-city.ca.us/city_services/depts/ecd/building/index.htm
www.ci.daly-city.ca.us/city_services/depts/ecd/planning/index.htm

appendix **twenty-eight**

Cost Proposal Form

Revision History

Revision	Date	Change	Approval
0	12/16/2009	Release for RFQ/RFP	n/a

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
Design Engineering Services					
1.	Design engineering services for the complete Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) and all other related components as described in Appendix 12 Technical Specifications. ****Note: Do not include costs on this line for project management, construction management, software development, or system testing. These costs should be included as specified below.	___	LS	___	
Allowance Line Items					
2.	Allowance for use by the City to address unforeseen site construction and fixed-equipment installation issues. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	___	LS	___	$250,000
3.	Allowance for use by the City to address unforeseen vehicle equipment installation issues. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	___	LS	___	$250,000

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
4.	Allowance for use by the City for developing system reports (see Appendix 12, Section 3.2), setting up of reporting distribution lists, and other related services. Work shall be ordered in writing by the Engineer by means of a written Change Order. No extra work shall be performed or expenses incurred that have not been authorized by a written change order. Work that has not been so authorized will not be paid for.	___	LS	___	$150,000
Portable Equipment Line Items					
5.	Supply and programming of Portable Tier I P25 compliant equipment for transit and PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	525	EA		
6.	Supply and programming of Portable Tier II P25 compliant equipment for PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	30	EA		
7.	Supply and programming of Portable Tier III P25 compliant equipment for PSVRN users, including antenna and battery (see Appendix 12 Section 2.7).	20	EA		
Non-Revenue Vehicle Equipment, Supply and Installation Line Items					
8.	Supply and installation of mobile equipment in non-revenue vehicles, “Configuration A” (see Appendix 12, Section 3.2).	100	EA		
9.	Supply and installation of mobile equipment in non-revenue vehicles, “Configuration B” (see Appendix 12, Section 3.2).	90	EA		
10.	Supply and installation of mobile equipment in non-revenue vehicles, “Configuration C” (see Appendix 12, Section 3.2).	50	EA		

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
Revenue Vehicles Equipment and Installation Line Items					
11.	Supply and installation of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel Hybrid Electric, Orion, 30-foot.	35	EA		
12.	Supply and installation of mobile radio(s) and Base ITS equipment (see Appendix 12 Section 3.2) in motor coaches of type: Diesel Hybrid Electric, Orion, 40-foot.	65	EA		
13.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in motor coaches of type: Diesel, NABI, 40-foot.	55	EA		
14.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in motor coaches of type: Diesel, Neoplan, 40-foot.	225	EA		
15.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in motor coaches of type: Diesel, Neoplan, 60-foot.	150	EA		
16.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in motor coaches of type: Diesel, Gillig, 40-foot.	60	EA		
17.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in motor coaches of type: Diesel, NewFlyer, 60-foot.	10	EA		
18.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: ETI, 40-foot.	275	EA		
19.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: ETI, 60-foot.	45	EA		
20.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in electric trolley coaches of type: NewFlyer, 60-foot.	75	EA		

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
21.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in Breda Light Rail Vehicles. Costs should NOT include the Digital Visual and Announcement System included in Item # 23.	160	EA		
22.	Supply of equipment, installation, system integration, and testing of the Light Rail Vehicle Digital Visual and Announcement System (see Appendix 12, Section 3, Appendix 22, and Appendix 23).	160	EA		
23.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: St. Louis Car, SEPTA PCC Style.	20	EA		
24.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Double-Ended PCC Style.	10	EA		
25.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Muni PCC 1 (1040) Style.	2	EA		
26.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: St. Louis Car, NJT Newark PCC Style.	12	EA		
27.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Fiat/Breda, Milan PW Style.	15	EA		
28.	Supply and installation of mobile radio(s) and Base ITS (see Appendix 12 Section 3.2) equipment in historic street cars of type: Vintage Style.	15	EA		
29.	Supply and installation of AVL equipment (see Appendix 12 Section 3.2) in Cable Cars of type: Powell Street Style.	35	EA		
30.	Supply and installation of AVL equipment (see Appendix 12 Section 3.2) in Cable Cars of type: California Street Style.	15	EA		

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
Fixed-End Equipment, Construction, and Interface Items					
31.	Procurement (supply) of all fixed-end equipment and material for a complete Multimodal Transit Management System (MTMS) including **six (6)** 800 MHz MTMS transit data/voice channels and **nine (9)** P-25 compliant PSVRN 700 MHz voice channels. Includes equipment and material for all surface street tunnels, underground rail tunnels, platforms, fixed guide ways, and all other associated components. ****Note #1: Include all costs (other than design and construction) for project management, construction management, software development, system testing, and training. ****Note #2: Do not include supply and installation of radiating transmission line throughout all surface street tunnels, underground rail tunnels, platforms, and storage tracks. This cost for this should be itemized below on line #41.	___	LS	___	
32.	Construction, installation, and testing of equipment at the Bernal Heights prime communications site, including all other interim network locations.	___	LS	___	
33.	Construction, installation, and testing of equipment at the Forest Hill communications site.	___	LS	___	
34.	Construction, installation, and testing of equipment at the CRS Twin Peaks communications site.	___	LS	___	
35.	Construction, installation, and testing of equipment at the One Market Plaza communications site.	___	LS	___	
36.	Construction, installation, and testing of equipment at the South Hill communications site.	___	LS	___	

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
37.	Construction, installation, and testing of equipment at the Clay and Jones communications site.	___	LS	___	
38.	Construction, installation, and testing of equipment at Lenox Way Operations Control Center communications site.	___	LS	___	
39.	Construction, installation, and testing of equipment at the interim rubber-tire dispatch center at One South Van Ness Avenue.	___	LS	___	
40.	Construction, installation, and testing of equipment for in-building communications equipment in all surface street tunnels, underground rail tunnels, and platforms, with the exception of radiating transmission line.	___	LS	___	
41.	Supply, installation, and testing of radiating transmission line throughout all surface street tunnels, underground rail tunnels, platforms, and storage tracks.	70,000	FT		
42.	Including line items #31 through #41 procurement, installation, and testing of equipment for **nine (9)** additional 700 MHz P-25 compliant PSVRN channels.	___	LS	___	
43.	For line item #42, Construction, installation, and testing of equipment at the Bernal Heights communications site, including all other interim network locations.	___	LS	___	
44.	For line item #42, Construction, installation, and testing of equipment at the Forest Hill communications site.	___	LS	___	
45.	For line item #42, Construction, installation, and testing of equipment at the CRS Twin Peaks communications site.	___	LS	___	
46.	For line item #42, Construction, installation, and testing of equipment at the One Market Plaza communications site.	___	LS	___	
47.	For line item #42, Construction, installation, and testing of equipment at the South Hill communications site.	___	LS	___	

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
48.	For line item #42, Construction, installation, and testing of equipment at the Clay and Jones communications site.	___	LS	___	
49.	For line item #31, Construction, installation, and testing of all MTMS and PSVRN equipment at all SFMTA vehicle maintenance facilities - Potrero, Muni Metro East, Presidio, Green, Woods, Flynn, Cable Car Barn, and Islais Creek (planned).	___	LS	___	
50.	Project 25 ISSI Software License, including professional services for installation and configuration	1	EA		
51.	TransLink On-Board Interface to MTMS (Revenue Vehicles, see Appendix 12, Section 3)	1229	EA	___	
52.	Cubic Farebox Interface to MTMS (Revenue Vehicles, see Appendix 12, Section 3)	1229	EA	___	
53.	Trapeze interface (see Appendix 12, Section 3)	___	LS	___	
54.	NextBus System interface (see Appendix 12, Section 3)	___	LS	___	
55.	MTC 511.org interface (see Appendix 12, Section 3)	___	LS	___	
Warranty Items					
56.	One (1) year of Warranty Support for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with **six (6)** 800 MHz MTMS data/voice channels and **nine (9)** 700 MHz P-25 compliant PSVRN voice channels (See Appendix 12, Section 8.3).	___	LS	___	

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
57.	One (1) year of Warranty Support for equipment for **nine (9)** additional 700 MHz P-25 compliant PSVRN voice channels (See Appendix 12, Section 8.3).	___	LS	___	
Subtotal – Complete MTMS and PSVRN Systems and One (1) Year Warranty					
Base System Spare Parts Items					
58.	Mobile Voice Radio	85	EA		
59.	Mobile Data Radio (if applicable)	85	EA		
60.	Mobile Voice Radio	20	EA		
61.	Mobile Data Radio (if applicable)	20	EA		
62.	Mobile Data Terminal	85	EA		
63.	Vehicle Logic Unit	85	EA		
64.	On-Board Electronic Sign	50	EA		
65.	On-Board Public Address Amplifier	85	EA		

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
66.	Complete set of revenue vehicle hardware including all equipment, cables, connectors, and brackets (assume for Transit Bus, 40 ft.)	10	EA		
67.	Complete set of revenue vehicle hardware including all equipment, cables, connectors, and brackets, Light Rail Vehicle	2	EA		
68.	Complete set of non-revenue vehicle hardware including all equipment, cables, connectors, and brackets (assume for sedan)	5	EA		
69.	Dispatch Voice Radio Console, including all hardware, software, and applicable software licenses.	3	EA		
70.	Dispatch CAD/AVL Console, including all hardware, software, and applicable software licenses.	3	EA		
71.	CAD/AVL software license, read-only	5	EA		
72.	Portable Radio, Tier I, P25 compliant, including antenna and battery	50	EA		
73.	Portable Radio, Tier II, P25 compliant, including antenna and battery	2	EA		
74.	Portable Radio, Tier III, P25 compliant, including antenna and battery	2	EA		
				Subtotal – Spare Parts	

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
Optional Services Items *******Note: Option prices shall cover all costs of the option work only and shall not include Base Bid work. Option prices shall include markups for overhead and profit.**					
75.	Over the Air Programming for portable radios (see Appendix 12 Section 2.17)	700	EA		
76.	Over the Air Re-keying for portable radios (see Appendix 12 Section 2.17)	50	EA		
77.	Encryption – Subscriber to Subscriber (see Appendix 12 Section 2.17)	50	EA		
78.	Intrinsically safe portable radio, Tier II (see Appendix 12 Section 2.17)	25	EA		
79.	Automatic Passenger Counting System Interface (see Appendix 12 Section 3.3)	1229	EA		
80.	Track Layout and Turnaround Layer (see Appendix 12 Section 3.3)	___	LS	___	
81.	Headway Control (see Appendix 12 Section 3.3)	___	LS	___	
82.	“Crush-Load” Detection with Wheelchair Priority Pickup (see Appendix 12 Section 3.3)	___	LS	___	
83.	Electronic O-1 Sheet Reporting and Vehicle Health Monitoring (see Appendix 12 Section 3.3)	___	LS	___	
84.	Capture Vehicle Load Using Real-Time Automatic Passenger Count Input (see Appendix 12 Section 3.3)	1229	EA		

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
85.	Predictive Arrival and Departure Information System (see Appendix 12 Section 3.3)	___	LS	___	
86.	Predictive Subsystem and Web Services API (see Appendix 12 Section 3.3)	___	LS	___	
87.	Mobile Dispatch Computers (see Appendix 12 Section 3.3)	30	EA		
88.	Traffic Signal Priority Interface (see Appendix 12 Section 3.3)	1229	EA		
89.	MTMS Development Environment (see Appendix 12 Section 3.3)	1	EA		
90.	Yard Management System for 995 vehicles (see Appendix 12 Section 3.3) at the following vehicle maintenance facilities - Potrero, Muni Metro East, Presidio, Green, Woods, Flynn, and Islais Creek (planned)	___	LS	___	
91.	SFgo CCTV Feed (see Appendix 12 Section 3.3), Lenox Way dispatcher workstations	11	EA		
92.	Geographically separated MTMS hot standby system (see Appendix 12 Section 3.3)	___	LS	___	
93.	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with **six (6)** 800 MHz MTMS data/voice channels and **nine (9)** 700 MHz P-25 compliant PSVRN voice channels. – Year 1 (See Appendix 12 Section 8.3).	___	LS	___	
94.	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with **six (6)** 800 MHz MTMS data/voice channels and **nine (9)** 700 MHz P-25 compliant PSVRN voice channels. – Year 2 (See Appendix 12 Section 8.3).	___	LS	___	

LS = Lump Sum, EA = Each, HR = Hour, MO = Month, YR = Year, FT = Foot					
Item No.	**Item Description**	**Estimated Quantity**	**Unit**	**Unit Price**	**Total Amount**
95.	Three (3) Year Extended Support Program for the Multimodal Transit Management System (MTMS) and Public Service Voice Radio Network (PSVRN) with **six (6)** 800 MHz MTMS data/voice channels and **nine (9)** 700 MHz P-25 compliant PSVRN voice channels. – Year 3 (See Appendix 12 Section 8.3).	___	LS	___	
96.	Three (3) Year Extended Support Program for **nine (9)** additional P-25 compliant 700 MHz PSVRN voice channels. – Year 1 (See Appendix 12 Section 8.3).	___	LS	___	
97.	Three (3) Year Extended Support Program for **nine (9)** additional P-25 compliant 700 MHz PSVRN voice channels. – Year 2 (See Appendix 12 Section 8.3).	___	LS	___	
98.	Three (3) Year Extended Support Program for **nine (9)** additional P-25 compliant 700 MHz PSVRN voice channels. – Year 3 (See Appendix 12 Section 8.3).	___	LS	___	
Subtotal – Optional Services Items					
Grand Total – Complete MTMS and PSVRN Systems, One (1) Year Warranty, Spare Parts, and Optional Services Items					

appendix **twenty-nine**

Light Rail Vehicle Drawings

for reference only

SECTION 11-3

COMMUNICATIONS

INTEGRATED WIRINGS DATA AND DIAGRAMS/SCHEMATICS COLLECTION

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SECTION 11-3

COMMUNICATIONS

INTEGRATED WIRINGS DATA AND DIAGRAMS/SCHEMATICS COLLECTION

11-3.1 Abbreviations, Acronyms and Symbols

11-3.1.1 List of Abbreviations, Acronyms and Symbols

The Abbreviations, Acronyms and Symbols commonly used throughout this section are given below with their relevant meaning.

Abbreviation	Meaning
AC	Alternating Current
AUX	Auxiliary
BCF	Breda Costruzioni Ferroviarie
DWG	Drawing
ECBCL	Equipment Circuit Board Components Layouts
ECBS	Equipment Circuit Board Schematics
E.I.C.	Equipment Identification Code
EQUIP	Equipment
H.V.	High Voltage (600 VDC)
H-PM	Heavy Preventive Maintenance
H-PMM	Heavy Preventive Maintenance Manual
HRWM	Heavy Repair and Workshop Manual
IDENT	Identification
IWD	Integrated Wiring Diagrams
IWT	Integrated Wiring Tables
L.V.	Low Voltage (37.5 VDC)
L.I. Code	Location Illustration Code
LOC	Location
P & PD	Piping and Pneumatic Drawing
RMSM	Running Maintenance and Service Manual
R-PM	Running Preventive Maintenance
R-PMM	Running Preventive Maintenance Manual
RWIT	Raceway and Wiring Identification Tables
SIWD	Subsystem Internal Wiring Diagrams

11-3.1.2 List of Definitions (Not Applicable)

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11-3.2 Foreword

This section provides the Maintainer with specific System & Subsystem Wiring Data, Wiring Diagrams/Schematics (including Circuit Boards) and Piping & Pneumatic Drawings pertaining to the LRV2's COMMUNICATIONS SYSTEM (Vehicles # 1400 through 1476).

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) "finding" and /or "putting back", on each Diagram/Schematic and on its own relevant envelope the relevant Manual Page # is provided.

- The System (specific) Integrated Wiring Diagrams (IWD) (produced by BREDA) are provided in para 11-3.3.

  The System (specific) IWD are collected and presented by Sheet # order (in numerical sequence starting from the lower to the higher Sheet #).

- The complete collection of BREDA DWG 4.00.000 SCHEMATICS is provided in Volume M 04 -Q.

- The Subsystem (specific) Internal Wiring Diagrams (SIWD) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.4.

  The Subsystem (specific) SIWD Diagrams identified by both BCF File # and by Supplier File #, are presented by BCF File # order (In numerical sequence starting from the lower to the higher File #).

  The Subsystem (specific) SIWD Diagrams identified only by Supplier File #, are collected immediately after those SIWDs identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

- The Integrated Wiring Tables (IWT) (produced by BREDA) are provided in para 11-3.5.

  The System (specific) IWT are collected and presented by BREDA Equipment Identification Code (provided in Table 11-1.2, section 11-1) in alphabetic sequence.

- The Equipment Circuit Board Schematics (ECBS) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.6.

  The ECBS identified by both BCF File # and by Supplier File, are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).

  The ECBS identified only by Supplier File # are collected immediately after those ECBS identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

- The Equipment Circuit Board Component Layouts (ECBCL) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.7.

  The ECBCL , identified by both BCF File # and by Supplier File, # are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).

  The ECBCL identified only by Supplier File, # are collected immediately after those ECBCL identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

- The System Piping & Pneumatic Drawings (P & PD) are provided in para 11-3.8.

  The P & PD, identified by both BCF File # and by Supplier File #, are presented by BCF file # order (in numerical sequence starting from the lower to the higher File #).

  The P & PD identified only by Supplier File # are collected immediately after those P & PD identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

The following Table 11-3.1 “LRV2 (VEHICLES # 1400 THROUGH 1476) SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATIC AND MAINTENANCE MANUALS CROSS REFERENCE” provides (by BREDA Equipment Identification Code in alphabetical sequence) for each Equipment/ Component pertaining to the COMMUNICATIONS SYSTEM, the relationships with the previously indicated IWD, SIWD, IWT, ECBS, ECBCL and P & PD.

For completeness, Table 11-3.1 provides also for each Equipment/Component listed, the references to:

- The RMSM and HRWM where the specific Equipment “Running” and “Heavy” Maintenance Tasks are detailed.
- The R-PM and H-PM Sheets (contained in the R-PMM and H-PMM respectively) where the specific Equipment “Running” and “Heavy” Preventive Maintenance are described.

TABLE 11-3.1 LRV2 – (VEHICLES # 1400 THROUGH 1476)

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	CA	RADIO ANTENNA	N.A.	31A	C8, D7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	H3	4.00.235 SH. 3 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.59	11-3.5	11-3.83	11-3.88
	CB	COMMUNICATION AMPLIFIER CONTROL UNIT	N.A.	31A	(CDE)5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	N.A.	4.00.233 35-4161	SCHEMATIC COMMUN. AMPLIFIER & CONTROL UNIT	11-3.4	11-3.51	11-3.5	11-3.89	11-3.96
	CD	RADIO SILENT ALARM SWITCH	N.A.	31A	A7, C3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	--	--	--	--	11-3.4	--	11-3.5	11-3.97	11-3.102
	CF	SIGNPOST RECEIVER	N.A.	31A	D8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.103	11-3.106
	CH	SPEAKER EXTERIOR	N.A.	31A	A3, A6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	A1, B1	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.107	11-3.112
I	CI	INTERCOMMUNICATION UNIT PASSENGER AREA	N.A.	31A	G2, G5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	N.A.	4.00.232 10-4307	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.4	11-3.49	11-3.5	11-3.113	11-3.118
	CK	MOBILE DATA TERMINAL	N.A.	31A	(AB)8, (BC)2	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	MOTOROLA	N.A.	4.00.238 PEPS-32713-C	INTERCONNECT CABLING DIAGRAMS	11-3.4	11-3.61	11-3.5	11-3.119	11-3.128
	CL	INTERIOR SPEAKERS	N.A.	31A	A2, A3, A4, A5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	C1	4.00.235 SH. 2 35-4199 SH. 2	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.129	11-3.146
	CM	COMMUNICATION CONTROL UNIT	N.A.	30A	(BC)3, (BC)6	CAB TO CAB INTERCOM RESET	SEE SH. 30 (PAGE 11-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.31	TCS	(BH)(7-8), (BH)(1-2)	4.00.235 SH. 1 35-4199 SH. 1	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.55	11-3.5	11-3.147	11-3.152
				31A	(DE)2, (DE)6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	(BH)(7-8)	4.00.235 SH. 2 35-4199 SH. 2	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57			
	CP	RADIO POWER SUPPLY	N.A.	31A	F8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	H8	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.153	11-3.156
	CR	RADIO EQUIPMENT	N.A.	12D	C6	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 11-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.23	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.157	11-3.160
				31A	C8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35									
	CS	GOOSENECK MICROPHONE	N.A.	31A	E2, E6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	C8, F8	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	--	--	--
	CV	POWER LINE FILTER	N.A.	31A	D8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.161	11-3.164

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-3.1 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	CW	TERMINAL BOARD PANEL	N.A.	31A	E7,G7,F8,C7 D7,E6,E4,C3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	--	--	--	--	--	--	11-3.5	11-3.165	11-3.178
	KE	MAINTENANCE TELEPHONE JACK	N.A.	42C	B3,B4,B5,B6	MISCELLANEOUS	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.39	TCS	A(5-8)	4.00.235 SH.3 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.59	11-3.5	11-3.179	11-3.184
	SM	SWITCH RADIO	N.A.	31A	(ABC)6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	BREDA	(BC)3, (BD)3	4.00.745	WIRING DIAGRAM SWITCH RADIO	11-3.4	11-3.63	11-3.5	11-3.185	11-3.192
	TA	VIDEO SURVEILLANCE SYSTEM (PROVISION)	N.A.	N.A.	N.A.	N.A.	--	11-3.3	--	--	--	--	--	11-3.4	--	--	--	--
	TC	VIDEOCAMERA (PROVISION)	N.A.	--	--	--	--	11-3.3	--	--	--	--	--	11-3.4	--	--	--	--
	TM1	MICROPHONE FOR VIDEO SURVEILLANCE (PROVISION)	N.A.	--	--	--	--	11-3.3	--	--	--	--	--	--	--	--	--	--
	VA	TRANSPONDER	N.A.	45	A(3-7)	VETAG INTERCONNECTING		11-3.3	11-3.41	--	--	--	--	--	--	--	--	--
	VE	CODE CONTROL BOX (VETAG)	N.A.	12C	C4, C8	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 11-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.21	VAPOR	N.A.	4.92.310 28846134	BOX CODE CONTROL	11-3.4	11-3.65	11-3.5	11-3.193	11-3.198
				45	D(2-8)	VETAG INTERCONNECTING		11-3.3	11-3.41									
				27D	D2, D6	EXT. LIGHTING (TURN LIGHTS)	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.27									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-3.1 LRV2 - VEHICLES # 1400 THROUGH 1476
SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)
SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	CA	RADIO ANTENNA	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.9 11-2.10	R11-02-09-00-I R11-02-10-00-I	--
	CB	COMMUNICATION AMPLIFIER CONTROL UNIT	RADIO CONTROL AND CHIME GENERATOR (A1)	4.00.266 35-4162	SCHEMATIC RADIO CONTROL / CHIME GENERATOR BOARD	11-3.6	11-3.211	4.66.128 SH. 1-4 35-1159	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.7	11-3.223	N.A.	N.A.	11-3.8	--	11-2.3	R11-02-03-00-I	H11-02-03-00-T
			DC/DC CONVERTER (POWER SUPPLY) (A2)	35-4008	SCHEMATIC DC TO DC CONVERTER	11-3.6	11-3.213	4.66.171 35-1018	ASSEMBLY – 28V DC-TO-DC CONVERTER	11-3.7	11-3.239							
			CAB INTERCOM CONTROL (A3)	35-4180	SCHEMATIC CAB INTERCOM CONTROL BOARD	11-3.6	11-3.217	35-1179	PRINTED WIRING ASSEMBLY CAB INTERCOM CONTROL BD	11-3.7	11-3.265							
			PASSENGER INTERCOM CONTROL (A4)	35-4171	SCHEMATIC PASSENGER INTERCOM CONTROL BOARD	11-3.6	11-3.215	35-1170	PRINTED WIRING ASSEMBLY PASS INTERCOM CONTROL BD	11-3.7	11-3.231							
			PA COMMUNICATION CONTROL (A5)	4.00.265 35-4167	SCHEMATIC PA COMMUNICATION CONTROL BOARD	11-3.6	11-3.209	35-1166	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD	11-3.7	11-3.251							
			POWER AMPLIFIER (INTERIOR SPEAKER) (A6)	37-4041	SCHEMATIC POWER AMPLIFIER	11-3.6	11-3.219	37-1040	ASSEMBLY POWER AMPLIFIER	11-3.7	11-3.271							
			POWER AMPLIFIER (EXTERIOR SPEAKER) (A7)	37-4041	SCHEMATIC POWER AMPLIFIER	11-3.6	11-3.219	37-1040	ASSEMBLY POWER AMPLIFIER	11-3.7	11-3.271							
	CD	RADIO SILENT ALARM SWITCH	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	---	11-2.13	--	--
	CF	SIGNPOST RECEIVER	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.15	--	--
	CH	SPEAKER EXTERIOR	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.6	--	--
	CI	INTERCOMMUNICATION UNIT PASSENGER AREA	N.A.	4.00.232 10-4307	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.6	11-3.49	10-1310	ASSEMBLY PASSENGER INTERCOM P.C.B.	11-3.7	11-3.243	N.A.	N.A.	11-3.8	--	11-2.4	--	--
	CK	MOBILE DATA TERMINAL	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.16	--	--
	CL	INTERIOR SPEAKERS	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.5	--	--
	CM	COMMUNICATION CONTROL UNIT	N.A.	4.00.234 35-4146	SCHEMATIC COMM. CONTROL PANEL	11-3.6	11-3.205	4.66.170 35-1151	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.7	11-3.231	N.A.	N.A.	11-3.8	--	11-2.1	R11-02-01-00-I	--
	CP	RADIO POWER SUPPLY	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.7	R11-02-07-00-I	
	CR	RADIO EQUIPMENT	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.14	--	--
	CS	GOOSENECK MICROPHONE	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.2	--	--
	CV	POWER LINE FILTER	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.12	--	--
	CW	TERMINAL BOARD PANEL	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-3.1 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT.	CODE ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II (Cont'd)	KE	MAINTENANCE TELEPHONE JACK	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.8	--	--
	SM	SWITCH RADIO	SM1 RADIO SWICTH	4.00.000 SH. 34	ELECTRICAL DIAGRAM P.C.B. SM1 SWITCH RADIO	11-3.6	11-3.201	**4.94.360**	P.C.B. LAYOUT	11-3.7	11-3.241	N.A.	N.A.	11-3.8	--	11-2.11	--	--
			SM2 RADIO SWICTH	4.00.000 SH. 34A	ELECTRICAL DIAGRAM P.C.B. SM2 SWITCH RADIO	11-3.6	11-3.203	4.94.360	P.C.B. LAYOUT	11-3.7	11-3.241	N.A.	N.A.	11-3.8	--	11-2.11	--	--
	TA	VIDEO SURVEILLANCE SYSTEM (PROVISION)	N.A.	N.A.	**N.A.**	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-4	R11-04-00-00-T	--
	TC	VIDEOCAMERA (PROVISION)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-4	R11-04-01-00-T	H11-04-01-00-I
	TM1	MICROPHONE FOR VIDEO SURVEILLANCE (PROVISION)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	--	--	--
	VA	TRANSPONDER	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-3.1	R11-03-01-00-I	--
	VE	CODE CONTROL BOX (VETAG)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-3.2	R11-03-02-00-I	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

11-3.3 Integrated Wiring Diagrams (IWD)

The COMMUNICATIONS SYSTEM electrical connections with Vehicle's Systems, Subsystems and/or Equipment are provided in the following Integrated Wiring Diagrams (IWD) pertaining to BREDA DWG 4.00.000 (Vehicles # 1400 through 1476) and consisting of the IWD sheets listed in the following Table 11-3.2.

Table 11-3.2 COMMUNICATIONS SYSTEM – IWD LIST

S/N	SHEET #	TITLE	PAGE	NOTE
1	12A	LOW VOLTAGE DISTRIBUTION AUXILIARY BUS	11-3.17	Applicable only to Vehicles # 1400, 1401, 1403, 1449
2	12B	LOW VOLTAGE DISTRIBUTION SYSTEM BUS	11-3.19	Applicable only to Vehicles # 1400, 1401, 1403, 1449
3	12C	LOW VOLTAGE DISTRIBUTION AUXILIARY BUS	11-3.21	
4	12D	LOW VOLTAGE DISTRIBUTION SYSTEM BUS	11-3.23	
5	27B	EXT. LIGHTING (TURN LIGHTS)	11-3.25	Applicable only to Vehicles # 1400, 1401, 1403, 1449
6	27D	EXT. LIGHTING (TURN LIGHTS)	11-3.27	
7	30	CAB TO CAB INTERCOM RESET	11-3.29	Applicable only to Vehicles # 1400, 1401, 1403, 1449
8	30A	CAB TO CAB INTERCOM RESET	11-3.31	
9	31	COMMUNICATION SYSTEM	11-3.33	Applicable only to Vehicles # 1400, 1401, 1403, 1449
10	31A	COMMUNICATION SYSTEM	11-3.35	
11	42B	MISCELLANEOUS	11-3.37	Applicable only to Vehicles # 1400, 1401, 1403, 1449
12	42C	MISCELLANEOUS	11-3.39	
13	45	VETAG INTERCONNECTING	11-3.41	

All the trainline signals pertaining to the functions of the System/Equipment are represented in the relevant applicable Diagrams, along with the identification of the Coupler pins through which the above signals are trainlined between coupled vehicles.

This type of representation, which is different from the traditional method for representing electrical diagrams, simplifies troubleshooting since all the functions of a system are concentrated in one table (provided in A2 or higher format to increase readability) regardless of the Equipment/Component location on the Vehicle.

The wires represented in each IWD Sheet are identified exactly as they appear in the Vehicle.

Each IWD sheet depict the circuits as the appear with no power applied, unless specifically noted otherwise.

The IWD Sheets don't include the Subsystem Internal Wiring; only the interfaces of the Subsystems are provided.

Each IWD Sheet is produced by BREDA and is provided with an alphanumerical grid to allow cross referencing with other IWD Sheet(s) or with SIWD diagrams.

In addition the following cross references are provided on each IWD Sheet:

- **Wire continuation on multiple IWD Sheet**

  For Example: 11AC2 means: go to Sheet 11A, coordinated in position C2.

- **Reference to SIWD**

  It is indicated by an ✳ positioned near the specific Equipment to which the SIWD pertains and near the following note:

  FOR "ZZ" WIRING DIAGRAM SEE DWG VAPOR XXXXXXX BCF file 4.00.yyy (Zn)

  Where: **ZZ** indicates the Equipment Identification Code (EIC) of the specific Equipment
  (For complete BREDA Equipment Identification Code and Equipment Location on vehicle refer to Table 11-1.2.

  XXXXXXX indicates the BREDA SUPPLIER .FILE #

  4.00.yyy indicates the corresponding BREDA FILE #

  (Zn) indicates the co-ordinates of the BREDA SUPPLIER FILE # incoming wires .

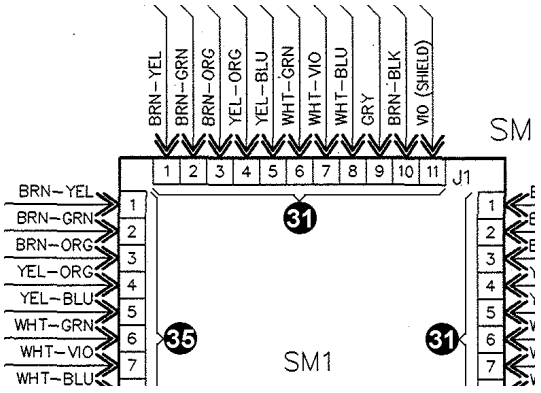
  (Z is a letter and may be A through H)

  (n is a number and may be 1 through 8).

In addition, when the relevant SIWD consists of several sheets, cross references between each Equipment (pertaining to the specific System), represented in the IWD and the relevant SIWD sheet (s) are provided for each wire or group of wires.

In function of the complexity of the drawing , and in order to highlight the references – notes ,the above wire or group of wires cross references are represented as indicated in the following examples:

1) The drawing available area to include the reference - note is small with respect to the reference – note dimensions (i.e. terminal board)



Refer to DWG BCF 4.00.000 Sh. 31A, Equipment "SM" (Switch Radio).

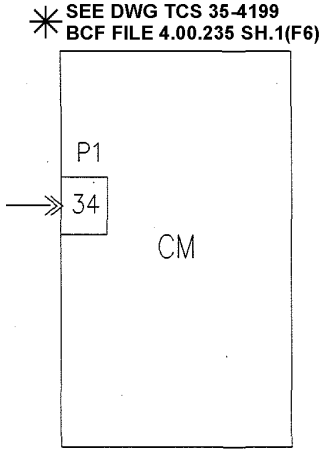
Go to location C6. Terminal board J1,

In this case a black spot with identification number (i.e. 31) is provided for each functional set of pins and the corresponding note

(i.e. 31 **SEE DWG BCF FILE 4.00.000 SH.34(AD)3**)

is provided in a suitable area of the drawing, next to the relevant terminal boards / pins.

2) The drawing available area to include the reference - note is suitable with respect to the reference – note dimensions (i.e. terminal board)



Refer to DWG BCF 4.00.000 Sh. 30A, Equipment "CM" (Communication Control Unit):

Go to location C3.

In this case the symbol ✳ is provided on each involved Equipment and the corresponding note

(i.e. **SEE DWG TCS 35-4199 BCF FILE 4.00.235 SH.1(F6)**)

is provided next to the relevant Equipment.

- **Reference to IWT**

  When applicable it is indicated in a dedicated area of each IWD Sheet, above the IWD Manual Page # by a Note as follow:

  SEE IWT – EQUIPMENT ZZ(A) PAGE 11-3.X
  ZZ(B) PAGE 11-3.Y

  Where: **ZZ** indicates the BREDA Equipment Identification Code. (For complete BREDA Equipment Identification Code and Equipment Location on vehicle refer to Table 11-1.2.)

  (A) indicates that the Equipment "ZZ" is installed on "A" Body Section.

  (B) indicates that the Equipment "ZZ" is installed on "B" Body Section.

  11-3.X indicates first page # of the relevant IWT Sheets where the Equipment ZZ (A) connection/wire data are listed.

  11-3.Y indicates first page # of the relevant IWT Sheets where the Equipment ZZ (B) connection/wire data are listed.

"A"

"B"

TBAUX

BD

CB14 5A · CB15 15A · CB16 5A · CB18 10A · CB19 10A · CB20 10A · CB22 10A · CB24 15A · CB25 10A · CB26 10A · CB28 15A · CB46 15A · CB32 5A · CB33 25A · CB34 5A

10D4 X1-1 AWG2 · IS5 · KB

TB9 · TB3 · TB10 · TB12 · TB10 · TB8 · TB9

VETAG	FARE BOX	PASSENGER REQUEST CONTROL & LIGHT	HVAC CONTROL	TRACK BRAKE CONTROL	COUPLER CONTROL	STEP CONTROL	ATCS #2 VOBC	T/L CONTROL # 1	T/L CONTROL # 2	ATCS #1 DU	ATCS PASSENGER ANNUNCIATION (PA)	ATCS #3 P.S.U.	PANTOGRAPH CONTROL	PANTOGRAPH ACTUATOR	AIR COMPRESSOR CONTROL
50W	240W	150W	120W	100W	120W	150W	250W	150W	150W	150W		250W	80W	300W	50W

TB+ · TB− · TG · MXA50 · MXB16

NB AUX.

TB11

TO "KQ" 32A6 NB99 AWG12

TO "KR" 27BC6 NB85 AWG12

BD

CB14 5A · CB15 15A · CB16 5A · CB47 5A · CB18 10A · CB48 5A · CB20 10A · CB21 5A · CB23 60A · CB22 10A · CB28 10A · CB25 10A · CB26 10A · CB27 10A · CB29 5A · CB19 10A

10G3 X2-2 AWG2 · IS5 · KB

TB9 · TB5 · TB3 · TB5 · TB3 · TB8 · TB10 · TB9

VETAG	FARE BOX	PASSENGER REQUEST CONTROL	ADA−A	HVAC CONTROL	ADA−B	COUPLER CONTROL	SANDER CONTROL	PROPULSION CONTROL	STEP CONTROL	ATCS #1 DU	T/L CONTROL # 1	T/L CONTROL # 2	DESTINATION SIGN CONTROL	FRICTION BRAKE CONTROL	TRACK BRAKE CONTROL
50W	240W	150W	80W	120W	80W	120W	80W	400W	150W	150W	150W	150W	150W	80W	

TB+ · TB− · TG · MXB50 · MXB16

NB AUX.

TO "KQ" 32A4 NB99 AWG12

TO "KR" 38BC1 NB85 AWG12

N.B. : DISEGNO VALIDO SOLO PER I VEICOLI PROTOTIPO
REMARK : VALID DRAWING FOR PROTOTYPE VEHICLES ONLY
VEHICLE N° 1400−1401−1403−1449

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE / TOLERANCES: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPR
2	12/10/99	BONACCHI	LOMBARDI	ING.
1	06/07/99	CABEL	LOMBARDI	ING.
0	09/21/98	BONACCHI	NUONNO	DA

11-3.17

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.' S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE

QUANTITY: P. VEICOLO / P.VEHICLE · P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITIES

PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.

SOSTITUISCE IL / SUPERSEDED

FOGLIO / SHEET 12A DI / OF 51

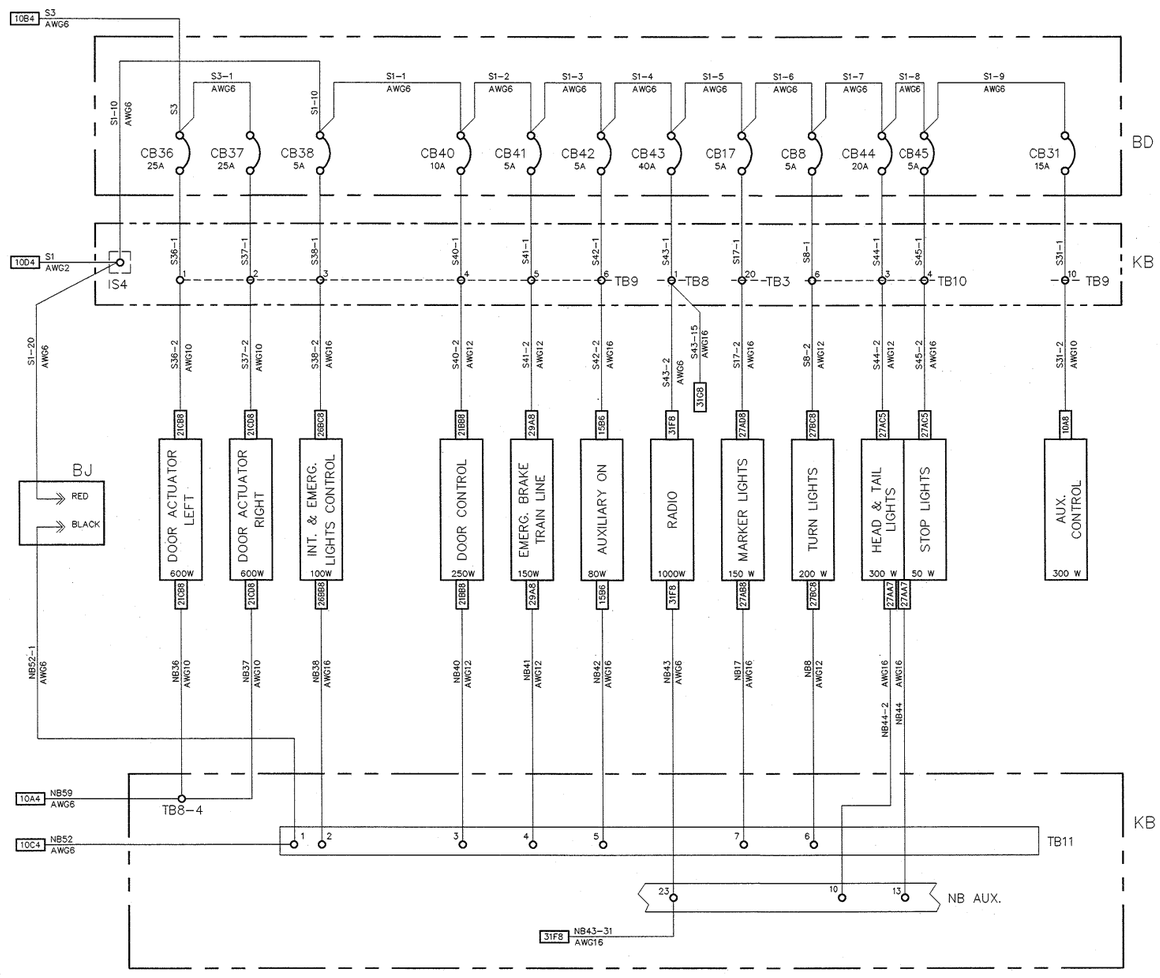
DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM

BREDA COSTRUZIONI FERROVIARIE

GENERAL AND PARTIAL WIRING DIAGRAM
L.V. DISTRIBUTION AUXILIARY BUS

TIPO / TYPE R07 · MATR. / FILE 4.00.000 · DISEGNO / DWG. N. 148908

COMMESSA / JOB 111B · CONTRACT N. #309



N.B. : DISEGNO VALIDO SOLO PER I VEICOLI PROTOTIPO
REMARK : VALID DRAWING FOR PROTOTYPE VEHICLES ONLY
VEHICLE N° 1400-1401-1403-1449

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. / Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPR
2	05/24/2000	BONACCHI	LOMBARDI	ING.
1	12/27/99	BONACCHI	LOMBARDI	ING.
0	08/25/99	BONACCHI	LOMBARDI	ING.

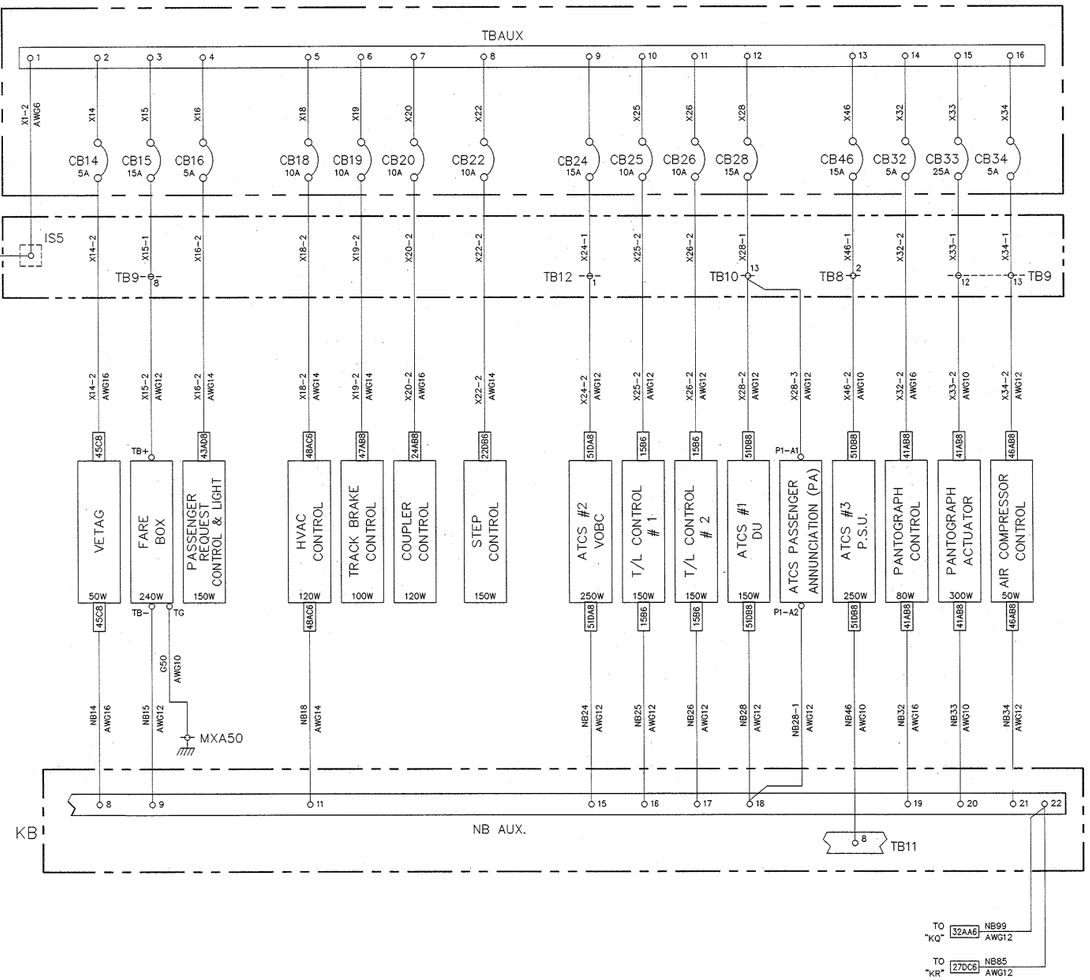
11-3.19

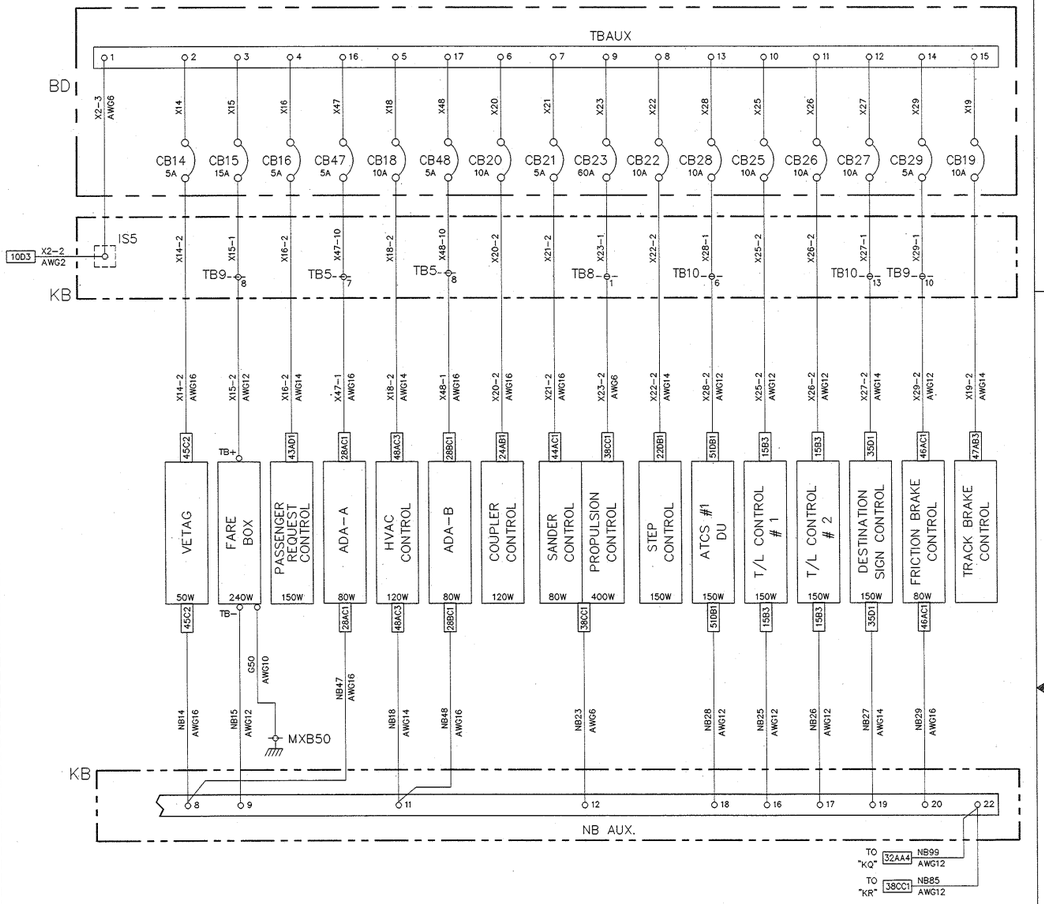
QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING-IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE
QUANTITY / QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK
UGUAGLIANZE / EQUALITES
PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.
SOSTITUISCE IL SUPERSEDED
FOGLIO / SHEET 12B DI OF 51

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM
GENERAL AND PARTIAL WIRING DIAGRAM
L.V. DISTRIBUTION SYSTEM BUS
TIPO TYPE R07
MATR. FILE 4.00.000
COMMESSA JOB I11B
CONTRACT N. #309
DISEGNO DWG. N. 148908

BREDA COSTRUZIONI FERROVIARIE





N.B. : DISEGNO VALIDO DAL 1° VEICOLO DELLA SERIE FINO AL 1476
REMARK : VALID DRAWING FROM 1st SERIES VEHICLE UNTIL 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE / TOLERANCES: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPR
2	01/11/96	BONACCHI	MORONI	BANDI
1	08/04/95	NESTI	MORONI	BANDI
0	06/22/94	CAMMARATA	MORONI	BAL

11-3.21

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE	QUANTITA' QUANTITY	UGUAGLIANZE / EQUALITIES	PESO UNITARIO / UNITARY WEIGHT Kg / Lbs.	FOGLIO / SHEET
	P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK	SOSTITUISCE IL SUPERSEDED		12C DI OF 51

DESCRIZIONE / DESCRIPTION		TIPO TYPE
BREDA COSTRUZIONI FERROVIARIE	ELECTRICAL SYSTEM GENERAL AND PARTIAL WIRING DIAGRAM L.V. DISTRIBUTION AUXILIARY BUS	R07 MATR. FILE 4.00.000 DISEGNO DWG. N. 136787
	COMMESSA JOB 111B — CONTRACT N. #309	

"A"

"B"

10B4 S3 AWG6
S3-1 AWG6
S1-1 AWG6
S1-2 AWG6
S1-3 AWG6
S1-4 AWG6
S1-5 AWG6
S1-6 AWG6
S1-7 AWG6
S1-8 AWG6
S1-9 AWG6
S1-10 AWG6
S3 AWG6
CB36 25A
CB37 25A
CB38 5A
CB40 10A
CB41 5A
CB42 5A
CB43 40A
CB17 5A
CB8 5A
CB44 20A
CB45 5A
CB31 15A
BD
KB
10D4 S1 AWG2
IS4
S36-1 AWG10
S37-1 AWG10
S38-2 AWG16
TB9
S40-2 AWG12
S41-2 AWG12
S42-2 AWG16
S43-1 AWG6
S43-15 AWG16
TB8
S17-2 AWG16
S8-2 AWG12
S44-2 AWG12
S45-2 AWG16
S31-1
S31-2 AWG10
10
S1-20 AWG6
BJ
RED
BLACK
DOOR ACTUATOR LEFT 600W
DOOR ACTUATOR RIGHT 600W
INT. & EMERG. LIGHTS CONTROL 100W
DOOR CONTROL 250W
EMERG. BRAKE TRAIN LINE 150W
AUXILIARY ON 80W
RADIO 1000W
MARKER LIGHTS 150 W
TURN LIGHTS 200 W
HEAD & TAIL LIGHTS 300 W
STOP LIGHTS 50 W
AUX. CONTROL 300 W
NB52-1 AWG6
NB36 AWG10
NB37 AWG10
NB38 AWG16
NB40 AWG12
NB41 AWG12
NB42 AWG16
NB43 AWG6
NB17 AWG16
NB8 AWG12
NB44-2 AWG16
NB44 AWG16
10A4 NB59 AWG6
TB8-4
10C4 NB52 AWG6
TB11
NB AUX.
31AF8 NB43-31 AWG16

10B3 S4-1 AWG6
S4-2 AWG6
S2-2 AWG6
S2-3 AWG6
S2-4 AWG6
S2-5 AWG6
S2-6 AWG6
S2-7 AWG6
S2-8 AWG6
S4-1 AWG6
S2-9 AWG6
CB36 25A
CB37 25A
CB38 5A
CB40 10A
CB41 5A
CB42 5A
CB17 5A
CB44 20A
CB45 5A
BD
KB
10C3 S2-1 AWG2
IS4
S36-1 AWG10
S37-1 AWG10
S38-2 AWG16
TB9
S40-2 AWG12
S41-2 AWG12
S42-2 AWG16
S17-2 AWG16
S44-2 AWG12
S45-2 AWG16
DOOR ACTUATOR LEFT 600W
DOOR ACTUATOR RIGHT 600W
INT. & EMERG. LIGHTS CONTROL 100W
DOOR CONTROL 250W
EMERG. BRAKE TRAIN LINE 150W
AUXILIARY ON 80W
MARKER LIGHTS 150 W
HEAD & TAIL LIGHTS 300 W
STOP LIGHTS 50 W
NB36 AWG10
NB37 AWG10
NB38 AWG16
NB40 AWG12
NB41 AWG12
NB42 AWG16
NB17 AWG16
NB44-2 AWG16
NB44 AWG16
10A3 NB60-1 AWG6
TB8-4
10B3 NB50-1 AWG6
TB11
NB AUX.

N.B. : DISEGNO VALIDO DAL PRIMO VEICOLO DELLA SERIE FINO AL 1476
REMARK : VALID DRAWING FROM 1st SERIES VEHICLE UNTIL 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E-TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPRO
2	05/15/98	TEXNO	NUONNO	DAN
1	06/16/97	BONACCHI	MORONI	DAN
0	06/22/94	CAMMARATA	MORONI	BAL

11-3.23

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE
QUANTITY P. VEICOLO / P.VEHICLE P. CARRELLO / P.TRUCK
UGUAGLIANZE / EQUALITIES
PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.
SOSTITUISCE IL SUPERSEDED
FOGLIO / SHEET 12D DI OF 51

DESCRIZIONE / DESCRIPTION ELECTRICAL SYSTEM
TIPO TYPE R07
GENERAL AND PARTIAL WIRING DIAGRAM
MATR. FILE 4.00.000
L.V. DISTRIBUTION SYSTEM BUS
COMMESSA JOB 111B
CONTRACT N. #309
DISEGNO DWG. N. 136787

BREDA COSTRUZIONI FERROVIARIE

"A" "B"

T/L EX KHP KHTB — TURN SIGNAL ON LEFT — ETO29 — EYP7 EYJ7 — ETO28 — TURN SIGNAL ON RIGHT — KHTB KHP EX T/L

T/L EX KHP KHTB — TURN SIGNAL ON RIGHT — ETO28 — EYP7 EYJ7 — ETO29 — TURN SIGNAL ON LEFT — KHTB KHP EX T/L

AC — VE — EMERGENCY LIGHT — A2-J1 A2-P1 — EYP11 EYJ11

KR — TB3 — TB1 — RLC — RRC — RTDL — RTDR — NBB5-2

KQ — TB3 — TLP2 — RR RL RCC — RAS — TLN2 — TB2 — KR

KBTB3 — KBTB5 — KBTB2

AC — A1-J1 A1-P1 — 50AD8 — TURN LIGHTS INDICATOR LEFT — TURN LIGHTS INDICATOR RIGHT — 50BD8

12BC5 S8-2 — 12BC5 NB8 — NBB5 12AB5

FOR VE EQUIPMENT SEE VAPOR DRAWING
28846134 BCF FILE 4.92.310

N.B. : DISEGNO VALIDO SOLO PER 1 VEICOLI PROTOTIPO
REMARK : VALID DRAWING FOR PROTOTYPE VEHICLES ONLY
VEHICLE N° 1400-1401-1403-1449

RLC AND RRC ARE STEPPING RELAIES

AWG 16
AWG14
AWG 12

LB1 LB3 LB2 — RIGHT SIDE LEFT — TURN LIGHTS

LB2 LB3 LB1 — LEFT SIDE RIGHT — TURN LIGHTS

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPRO
1	09/21/98	BONACCHI	NUONNO	DAI
0	09/21/94	BONACCHI	MORONI	BAL

11-3.25

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE	QUANTITA' QUANTITY	UGUAGLIANZE / EQUALITES	PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.	FOGLIO / SHEET
	N. VEICOLO / N.VEHICLE		SOSTITUISCE IL SUPERSEDED	27B DI OF 51
	N. CARRELLO / N.TRUCK			

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM
GENERAL AND PARTIAL WIRING DIAGRAM
EXT. LIGHTING (TURN LIGHTS)

TIPO TYPE R07
MATR. FILE 4.00.000
DISEGNO DWG. N. 148908

BREDA COSTRUZIONI FERROVIARIE

COMMESSA JOB I11B — CONTRACT N. #309

T/L EX KHP KHTB ETO29-L ETO29-1 TURN SIGNAL ON LEFT ETO29 27 EYP7 EYJ7 ETO28 TURN SIGNAL ON RIGHT ETO28 6-12 KHTB KHP EX T/L

ETO28-R ETO28-1 TURN SIGNAL ON RIGHT ETO28 28 ETO29 TURN SIGNAL ON LEFT ETO29 6-13 ETO29-L

"A" "B"

AC L R VE ✳ EMERGENCY LIGHT J2 A2-J1 A2-P1 EYP11 EYJ11

KR TB3 RLC RTDL RTDR RRC 470 µF 150 Ω 5W NB85-2 TB1

AC A1-J1 A1-P1 50AD8 58AA-1 58BA-1 TURN LIGHTS INDICATOR LEFT TURN LIGHTS INDICATOR RIGHT

12DC5 S8-2 NB8 KQ KBTB3 TB3 TLP2 RR RL RCC ETO68-24 RAS RL RR TLN2 ETO48-6 ETO48-7 ETO48-8 KR TB2 RDS RSUS

KBTB5 KBTB2 TURN LIGHTS INDICATOR LEFT TURN LIGHTS INDICATOR RIGHT

✳ FOR VE EQUIPMENT SEE VAPOR DRAWING 28846134 BCF FILE 4.92.310

* RLC AND RRC ARE STEPPING RELAIES

AWG 16 — AWG14 △ — AWG 12 ◎

RIGHT SIDE LEFT LB1 LB3 LB2 TURN LIGHTS

LEFT SIDE RIGHT LB2 LB3 LB1 TURN LIGHTS

N.B. : DISEGNO VALIDO DAL 1° VEICOLO DELLA SERIE
REMARK : VALID DRAWING FROM 1ST SERIES VEHICLE

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

SEE IWT – EQUIPMENT VE(A) PAGE 11-3.195 VE(B) PAGE 11-3.197

REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROV APPRO
2	09/05/94	BONACCHI	MORONI	BAL
1	09/05/94	BONACCHI	MORONI	BAL
0	06/24/94	BONACCHI	MORONI	BAL

11-3.27

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

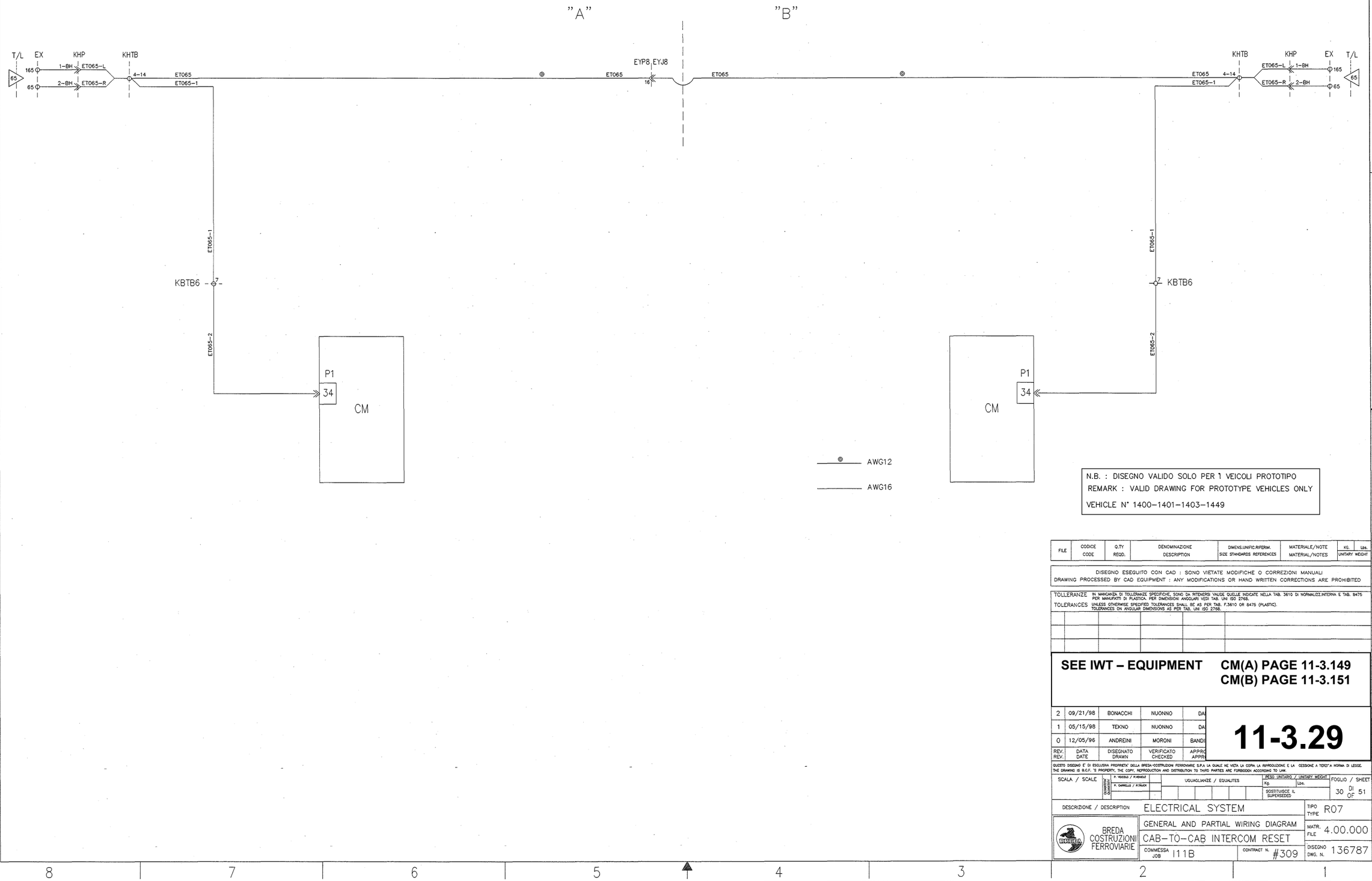
SCALA / SCALE — QUANTITY P. VEICOLO / P.VEHICLE, P. CARRELLO / P.TRUCK — UGUAGLIANZE / EQUALITIES — PESO UNITARIO / UNITARY WEIGHT Kg. Lbs. — SOSTITUISCE IL SUPERSEDED — FOGLIO / SHEET 27D DI OF 51

DESCRIZIONE / DESCRIPTION ELECTRICAL SYSTEM — TIPO TYPE R07

GENERAL AND PARTIAL WIRING DIAGRAM
EXT. LIGHTING (TURN LIGHTS)

MATR. FILE 4.00.000

BREDA COSTRUZIONI FERROVIARIE — COMMESSA JOB I 11 B — CONTRACT N. # 309 — DISEGNO DWG. N. 136787



N.B. : DISEGNO VALIDO SOLO PER 1 VEICOLI PROTOTIPO
REMARK : VALID DRAWING FOR PROTOTYPE VEHICLES ONLY
VEHICLE N° 1400–1401–1403–1449

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE / TOLERANCES: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

SEE IWT – EQUIPMENT **CM(A) PAGE 11-3.149** **CM(B) PAGE 11-3.151**

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPR
2	09/21/98	BONACCHI	NUONNO	DA
1	05/15/98	TEKNO	NUONNO	DA
0	12/05/96	ANDREINI	MORONI	BANDI

11-3.29

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA-COSTRUZIONI FERROVIARIE S.P.A. LA GUALE NE VIETA LA COPIA, LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE

QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITIES

PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.

SOSTITUISCE IL SUPERSEDED

FOGLIO / SHEET 30 DI OF 51

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM

BREDA COSTRUZIONI FERROVIARIE

GENERAL AND PARTIAL WIRING DIAGRAM

CAB–TO–CAB INTERCOM RESET

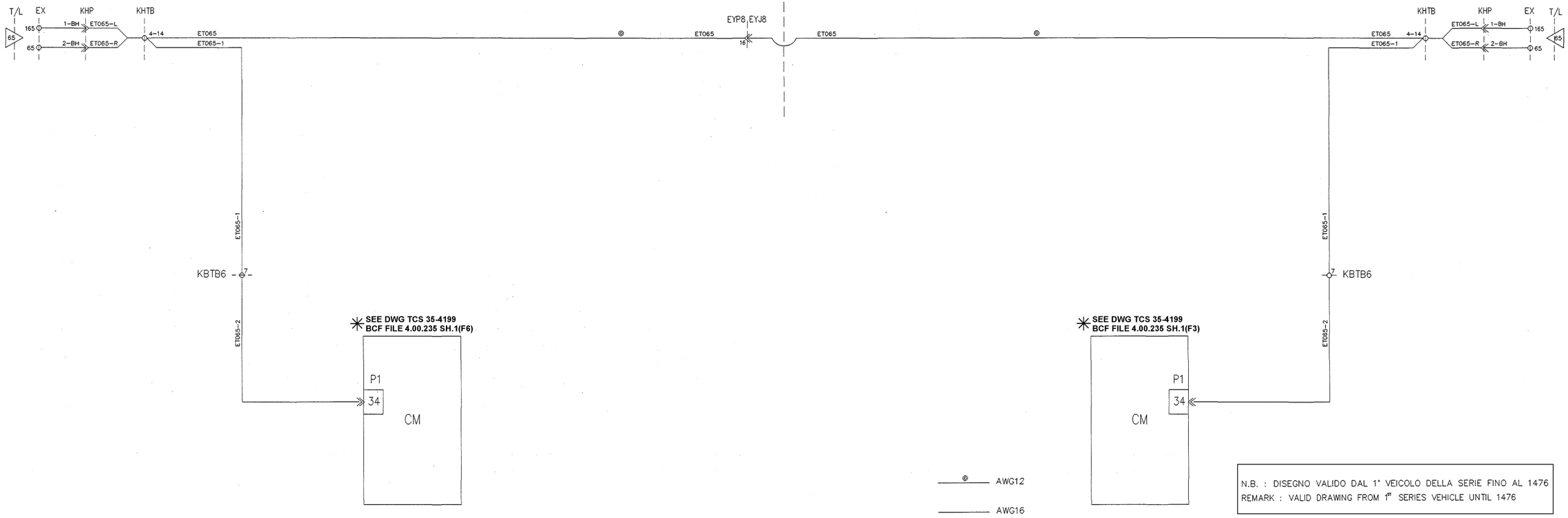
COMMESSA JOB I11B

CONTRACT N. #309

TIPO TYPE R07

MATR. FILE 4.00.000

DISEGNO DWG. N. 136787



N.B. : DISEGNO VALIDO DAL 1° VEICOLO DELLA SERIE FINO AL 1476
REMARK : VALID DRAWING FROM 1ST SERIES VEHICLE UNTIL 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE / TOLERANCES: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPR
2	06/14/99	BONACCHI	LOMBARDI	ING. D
1	05/15/98	TEKNO	NUONNO	DAN
0	12/05/96	ANDREINI	MORONI	BANDIN

11-3.31

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THIS DRAWING IS B.C.F.'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE

QUANTITA' PER VEICOLO: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITES

PESO UNITARIO / UNITARY WEIGHT: Kg. Lbs.

SOSTITUISCE IL SUPERSEDED

FOGLIO / SHEET 30A DI OF 51

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM
GENERAL AND PARTIAL WIRING DIAGRAM
CAB-TO-CAB INTERCOM RESET

TIPO TYPE R07
MATR. FILE 4.00.000
DISEGNO DWG. N. 136787

BREDA COSTRUZIONI FERROVIARIE

COMMESSA JOB 111B
CONTRACT N. #309

"A" "B"

THE INTERCONNECTING MULTICABLE BETWEEN "CR" AND "CK" IS MOTOROLA CABLE P/N TKN8127A OR EQUIV. WITH THE CODE COLORE SHOWS ON THE SCHEMATIC.

FOR INTERCONNECTING REFERENCE SEE ALSO "T.C.S." DWG. 35-4199 (BCF FILE 4.00.235) AND "MOTOROLA" DWG. PEPS-32713-C (BCF FILE 4.00.238).

I COMPONENTI CONTRASSEGNATI CON * SONO DI FORNITURA MUNI S.F.
COMPONENTS MARKED WITH * ARE PROVIDED BY MUNI S.F.

F1 = 40 Amp.
F2 - F3 = 7.5 Amp.

MOTOROLA CABLE TKN8023B	MOTOROLA CABLE TKN8023A
BRN-YEL	VIO
BRN-GRN	BRN
BRN-ORG	RED
YEL-ORG	YEL
YEL-BLU	BLU
WHT-GRN	GRN
WHT-VIO	WHT
WHT-BLU	BLK
GRY	GRY
BRN-BLK	GROUND
VIO(SHIELD)	WHT-GRN / GRN-BRN
	ORG / PINK

- N° 1 CAVO "PKN6133A" CASSA A
  DEVE ESSERE TAGLIATO PER CONSENTIRE I SEGUENTI COLLEGAMENTI :
  1) SYNTOR X RADIO "CR" – MORSETTIERA "CW"
  2) MORSETTIERA "CW" – SCHEDA MULTIPLEX "SM" IN KR
  3) SCHEDA MULTIPLEX "SM" – MORSETTIERA "KR"
  4) SCHEDA MULTIPLEX "SM" – MOBILE DATA TERMINAL "CK"
- N° 1 CAVO "PKN6133A" CASSA B
  DEVE CONSENTIRE IL SEGUENTE COLLEGAMENTO :
  1) MOBILE DATA TERMINAL "CK" – MORSETTIERA "CW"
- N° 1 CAVO "TKN8023B" CASSA A
  DEVE ESSERE TAGLIATO PER CONSENTIRE I SEGUENTI COLLEGAMENTI :
  1) PROCESSING UNIT "CF" – SCHEDA MULTIPLEX "SM"
  2) SCHEDA MULTIPLEX "SM" – MOBILE DATA TERMINAL "CK"
  3) SCHEDA MULTIPLEX "SM" – MORSETTIERA "KR"
- N° 1 CAVO "TKN8023B" CASSA B
  DEVE CONSENTIRE IL SEGUENTE COLLEGAMENTO
  1) MOBILE DATA TERMINAL "CK" – MORSETTIERA "KR"

AWG 6
AWG 12
AWG 16

DWG. VALID ONLY FOR 4 PROTOTIPIES
VEHICLE N°1400-1401-1403-1449

FILE	CODICE CODE	Q.TÀ REQU.	DENOMINAZIONE DESCRIPTION	DIMENSIONI/NORME SEE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	PZ.	UNI. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

REV. REV.	DATA DATE	DISEGNATO Drawn	VERIFICATO CHECKED	APPROVATO APPROVED	DESCRIZIONE DESCRIPTION
5	06/10/98	TENNC			
4	06/06/97	BONACC			
3	12/16/96	LEONI			
2	07/30/96	NUNNA			
1	01/10/96	BONACC			
0	10/30/95	BONACC			

11-3.33

DATI TECNICI E DI ESECUZIONE PROPRIETÀ BREDA SISTEMI DISTRIBUZIONE RISERVATA. LA COPIA DEL PRESENTE E LA RIPRODUZIONE E LA COMUNICAZIONE A TERZI A NORMA DI LEGGE, NE SONO VIETATE SENZA NOSTRA AUTORIZZAZIONE SCRITTA. ALL RIGHTS RESERVED. COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE | UNITÀ / FORMAT | UNIFICATO / UNIFIED | MODIFICATO / MODIFIED | FOGLIO / SHEET
NON SCALA | A4 | 31 DI OF 51

DISEGNATO / DRAWN: F. CARELLI / F.PACE
VERIFICATO: [illegible]
APPROVATO / SUPERVISED: [illegible]

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM
TIPO TYPE: R07
GENERAL AND PARTIAL WIRING DIAGRAM
COMMUNICATION SYSTEM
MATR. FILE: 4.00.000
COMMESSA JOB: I11B | CONTRATTO N. CONTRACT: #309 | DISEGNO DWG. N.: 148908

BREDA COSTRUZIONI FERROVIARIE

THE INTERCONNECTING MULTICABLE BETWEEN "CR" AND "CK" IS MOTOROLA CABLE P/N TKN8127A OR EQUIV. WITH THE CODE COLORE SHOWS ON THE SCHEMATIC.

FOR INTERCONNECTING REFERENCE SEE ALSO "T.C.S." DWG. 35-4199 (BCF FILE 4.00.235) AND "MOTOROLA" DWG. PEPS-32713-C (BCF FILE 4.00.238).

I COMPONENTI CONTRASSEGNATI CON * SONO DI FORNITURA MUNI S.F.
COMPONENTS MARKED WITH * ARE PROVIDED BY MUNI S.F.

F1 = 40 Amp.

F2 – F3 = 7.5 Amp.

MOTOROLA CABLE TKN8023B	MOTOROLA CABLE TKN8023A	
BRN–YEL	VIO	VIO
BRN–GRN	BRN	BRN
BRN–ORG	RED	RED
YEL–ORG	YEL	YEL
YEL–BLU	BLU	BLU
WHT–GRN	GRN	GRN
WHT–VIO	WHT	WHT
WHT–BLU	BLK	BLK
GRY	GRY	GRY
BRN–BLK	GROUND	GROUND
VIO(SHIELD)	WHT–GRN	ORG
	GRN–BRN	PINK

– N° 1 CAVO "PKN6133A" CASSA A
DEVE ESSERE TAGLIATO PER CONSENTIRE I SEGUENTI COLLEGAMENTI
1) SYNTOR X RADIO "CR" – MORSETTIERA "CW"
2) MORSETTIERA "CW" – SCHEDA MULTIPLEX "SM" IN KR
3) SCHEDA MULTIPLEX "SM" – MORSETTIERA "KR"
4) SCHEDA MULTIPLEX "SM" – MOBILE DATA TERMINAL "CK"

– N° 1 CAVO "PKN6133A" CASSA B
DEVE CONSENTIRE IL SEGUENTE COLLEGAMENTO :
1) MOBILE DATA TERMINAL "CK" – MORSETTIERA "CW"

– N° 1 CAVO "TKN8023B" CASSA A
DEVE ESSERE TAGLIATO PER CONSENTIRE I SEGUENTI COLLEGAMENTI
1) PROCESSING UNIT "CF" – SCHEDA MULTIPLEX "SM"
2) SCHEDA MULTIPLEX "SM" – MOBILE DATA TERMINAL "CK"
3) SCHEDA MULTIPLEX "SM" – MORSETTIERA "KR"

– N° 1 CAVO "TKN8023B" CASSA B
DEVE CONSENTIRE IL SEGUENTE COLLEGAMENTO
1) MOBILE DATA TERMINAL "CK" – MORSETTIERA "KR"

SEE IWT – EQUIPMENT

CA1 (A) PAGE 11-3.85
CB (A) PAGE 11-3.91
CD (B) PAGE 11-3.101
CH (A) PAGE 11-3.109
CI (A) PAGE 11-3.115
CK (A) PAGE 11-3.121
CL1 (A) PAGE 11-3.131
CL2 (A) PAGE 11-3.135
CL3 (A) PAGE 11-3.139
CL4 (A) PAGE 11-3.143
CM (A) PAGE 11-3.149
CP (A) PAGE 11-3.155
CV (A) PAGE 11-3.163
CW (B) PAGE 11-3.175
CA2 (A) PAGE 11-3.87
CD (A) PAGE 11-3.99
CF (A) PAGE 11-3.105
CH (B) PAGE 11-3.111
CI (B) PAGE 11-3.117
CK (B) PAGE 11-3.125
CL1 (B) PAGE 11-3.133
CL2 (B) PAGE 11-3.137
CL3 (B) PAGE 11-3.141
CL4 (B) PAGE 11-3.145
CM (B) PAGE 11-3.151
CR (A) PAGE 11-3.159
CW (A) PAGE 11-3.167
SM (A) PAGE 11-3.187

AWG 6
AWG 12
AWG 16

VALID DRAWING FROM 1ST SERIES VEHICLE UNTIL 1476
DISEGNO VALIDO DAL 1° VEICOLO DELLA SERIE FINO AL 1476

0	07/0	TD CFD–1061	
REV.	DA		
REV.	DA		
SCALA /		FOGLIO / SHEET	31A 51
DESCRIZIONE / DESCRIPTION	ELECTRICAL SYSTEM	SIGLA TYPE	R07
BREDA COSTRUZIONI FERROVIARIE	GENERAL AND PARTIAL WIRING DIAGRAM	MATR. FILE	4.00.000
	COMMUNICATION SYSTEM	DISEGNO DWG. N.	148908
COMMESSA JOB	111B	CONTRACT N.	#309

11-3.35

"A"

"B"

"CONSOLLE LIGHTING"

"SOUND POWERED TELEPHONE JACK"

I COMPONENTI MARCATI CON * SONO DI FORNITURA ALCATEL
COMPONENTS MARKED WITH * ARE SUPPLIED BY ALCATEL

N.B. : DISEGNO VALIDO SOLO PER I VEICOLI PROTOTIPO
REMARK : VALID DRAWING FOR PROTOTYPE VEHICLES ONLY

VEHICLE N° 1400–1401–1403–1449

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	DESCRIZIONE DESCRIPTION
3	01/15/99	CABEL	LOMBARDI		
2	09/21/98	BONACCHI	NUONNO	DAN	
1	06/12/97	BONACCHI	MORONI	DAN	
0	07/08/96	NUONNO	MORONI	BANDIN	

11-3.37

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA, LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE	QUANTITA' QUANTITY	UGUAGLIANZE / EQUALITES	PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.	FOGLIO / SHEET
	P. MOTRICI / P.MOTRICE P. CARRELLO / P.TRUCK		SOSTITUISCE IL SUPERSEDED	42B DI OF 51

DESCRIZIONE / DESCRIPTION	ELECTRICAL SYSTEM	TIPO TYPE R07
BREDA COSTRUZIONI FERROVIARIE	GENERAL AND PARTIAL WIRING DIAGRAM MISCELLANEOUS	MATR. FILE 4.00.000
COMMESSA JOB I11B	CONTRACT N. #309	DISEGNO DWG. N. 159957

"A"

"B"

"CONSOLLE LIGHTING"

"SOUND POWERED TELEPHONE JACK"

I COMPONENTI MARCATI CON * SONO DI FORNITURA ALCATEL
COMPONENTS MARKED WITH * ARE SUPPLIED BY ALCATEL

N.B. : DISEGNO VALIDO DAL 1° VEICOLO DELLA SERIE
REMARK : VALID DRAWING FROM 1ST SERIES VEHICLE

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

SEE IWT – EQUIPMENT

KE(A) PAGE 11-3.181
KE(B) PAGE 11-3.183

REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED
2	08/30/95	NESTI	MORONI	BANDI
1	17/07/95	NESTI	MORONI	BANDI
0	06/24/94	CAMMARATA	MORONI	BAL

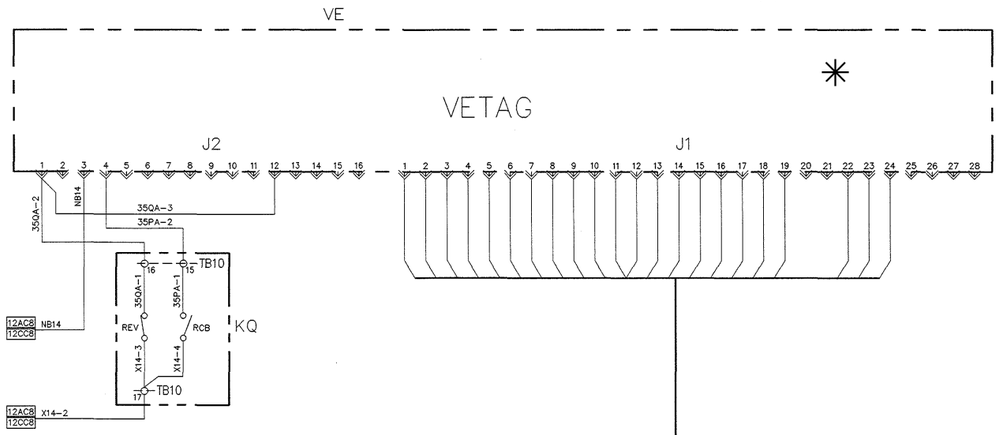
11-3.39

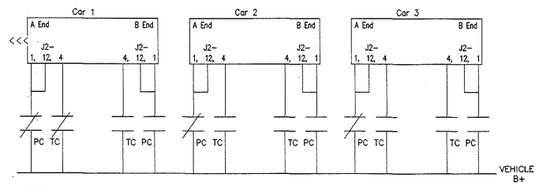
QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.'S PROPERTY. THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE	QUANTITA' PER QUANTITY PER	UGUAGLIANZE / EQUALITIES	PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.	FOGLIO / SHEET
	P. VEICOLO / P.VEHICLE P. CARRELLO / P.TRUCK		SOSTITUISCE IL SUPERSEDED	42C DI OF 51

DESCRIZIONE / DESCRIPTION		TIPO TYPE
	ELECTRICAL SYSTEM	R07
BREDA COSTRUZIONI FERROVIARIE	GENERAL AND PARTIAL WIRING DIAGRAM	MATR. FILE 4.00.000
	MISCELLANEOUS	
COMMESSA JOB I11B	CONTRACT N. #309	DISEGNO DWG. N. 136787

"A"





NOTES :

1. J2 = Vehicle electrical input connector to VETAG Code Control Box
2. PC = Power Contact – when closed supplies vehicle low voltage B+ to operate the Code Control Box and Transponder. PC is closed in all "Front Cabs" and open in all rear cabs.
3. TC = Transfer Switch Contact – Supplies vehicle low voltage B+ in the "Front" , "LEAD CAB" , only. In all trailing "Front Cabs" , TC must be open.
4. J2 connector , Pin #3 is connected to vehicle B–
5. For further information regarding connector J2 , see Vapor Drawing 28846134.

Three–Car Functional Truth Table

	PC	TC
Car 1A	closed	closed
Car 1B	open	open
Car 2A	closed	open
Car 2B	open	open
Car 3A	closed	open
Car 3B	open	open

6. External connections to J2 by others
7. Reverence Vapor Technical Proposal TP91–2
8. This drawing supersedes SK091693MW Rev A

ELECT. INTERFACE INFO FOR VAPOR CODE CONTROL BOX P/N 28846134 USED ON MUNI SLRV CARS (MR–1034R)

DRAWING REFERENCE NBR: SK093093MW

PC = ON BCF SCHEMATIC EQUIVALENT TO "REV" CONTACT

TC = ON BCF SCHEMATIC EQUIVALENT TO "RCB" CONTACT

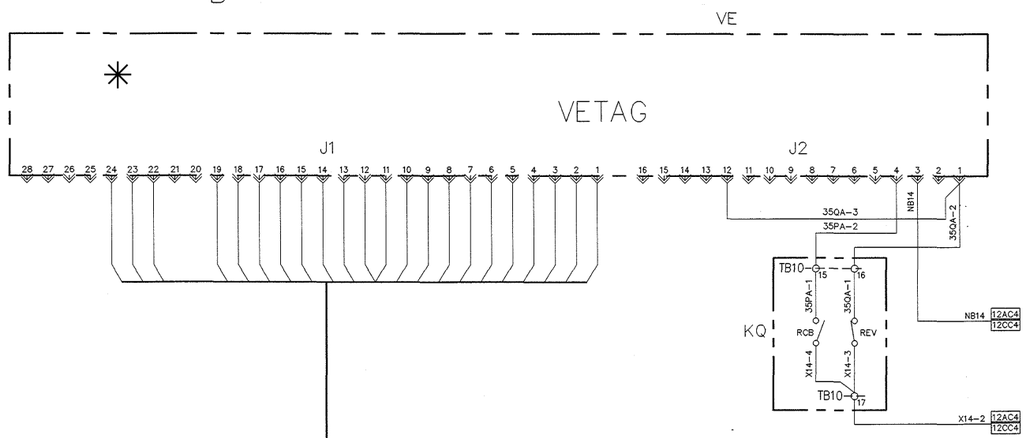
VA

TRANSPONDER

✳ SUPPLY BY VAPOR
DWG. 28846134
BCF FILE 4.92.310

AWG 16

"B"



WIRE TABLE CONNECTOR J2	
PIN	FUNCTION
1	B + 37.5 V.
2	NOT USED
3	B –
4	CONTROLS BIT 19 (B+ = HIGH)
5	SPARE
6	SPARE
7	SPARE
8	SPARE
9	SPARE
10	SPARE
11	CONSIST END CAB
12	CAR END
13	NOT USED
14	"LEFT" TURN SIGNAL OUTPUT
15	NOT USED
16	"RIGHT" TURN SIGNAL OUTPUT

WIRE TABLE CONNECTOR J1		
WIRE COLOR	FUNCTION	PIN
BROWN/BLUE	VX	22
BROWN/PINK	BATTERY +	23
BLUE/WHITE	BATTERY –	24
PINK/WHITE	BIT 18	18
BROWN/GRAY	BIT 8	8
GRAY/WHITE	BIT 14	14
BROWN/YELLOW	BIT 4	4
YELLOW/WHITE	BIT 9	9
BROWN/GREEN	BIT 19	19
GREEN/WHITE	BIT 13	13
RED/BLUE	BIT 3	3
PINK/GRAY	BIT 17	17
VIOLET	BIT 7	7
BLACK	BIT 16	16
RED	BIT 6	6
BLUE	BIT 12	12
PINK	BIT 2	2
GRAY	BIT 15	15
YELLOW	BIT 5	5
GREEN	BIT 11	11
WHITE	BIT 1	1
BROWN	BIT 10	10

VA

TRANSPONDER

DISEGNO VALIDO FINO AL VEICOLO 1476
VALID DRAWING UNTILL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE / TOLERANCES: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPRO APPRO	
7	01/15/99	CABEL	LOMBARDI	[illegible]	DRAWING CONFORMED TO CFG–1119

SEE IWT – EQUIPMENT **VE(A) PAGE 11-3.195** **VE(B) PAGE 11-3.197**

2	11/03/93	BONACCHI	MORONI	BAL	
1	06/24/93	CALCAGNA	MORONI	BAL	
0	04/06/93	GIANNINI	MORONI	BAL	

11-3.41

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA, LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F.'S PROPERTY. THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE | QUANTITY: P. VEICOLO / P.VEHICLE, P. CARRELLO / P.TRUCK | UGUAGLIANZE / EQUALITIES | PESO UNITARIO / UNITARY WEIGHT Kg. Lbs. | SOSTITUISCE IL SUPERSEDED | FOGLIO / SHEET 45 DI OF 51

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM
GENERAL AND PARTIAL WIRING DIAGRAM
VETAG INTERCONNECTING

TIPO TYPE: R07
MATR. FILE: 4.00.000
COMMESSA JOB: 111B
CONTRACT N.: #309
DISEGNO DWG. N.: 136787

BREDA COSTRUZIONI FERROVIARIE

11-3.4 Subsystem Internal Wiring Diagrams (SIWD)

The COMMUNICATIONS SYSTEM Subsystem electrical connections are provided in the following Subsystem Internal Wiring Diagrams, (SIWD) produced by TCS, MOTOROLA and VAPOR and consisting of the SIWD Diagrams listed in the following Table 11-3.3.

Table 11-3.3 COMMUNICATIONS SYSTEM – SIWD LIST

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	REFERENCES					
				FROM IWD		TO ECBS		TO ECBCL	
				SHEET #	Page #	FILE #	Page #	FILE #	Page #
1	4.00.232 ---------- 10-4307	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.49	31A	11-3.35	N.A.	N.A.	10-1310	11-3.243
2	4.00.233 SH. 1 ---------- 35-4161 SH. 1	SCHEMATIC COMMUNCATION AMPLIFIER & CONTROL UNIT	11-3.51	31A	11-3.35	4.00.266 4.00.265 35-4008 35-4171 35-4180	11-3.211 11-3.209 11-3.213 11-3.215 11-3.217	4.66.128 4.66.171 35-1166 35-1170 35-1179	11-3.223 11-3.239 11-3.251 11-3.259 11-3.265
3	4.00.233 SH. 2 ---------- 35-4161 SH. 2	SCHEMATIC COMMUNCATION AMPLIFIER & CONTROL UNIT	11-3.53	31A	11-3.35	4.00.266 4.00.265 37-4041 35-4171 35-4180	11-3.211 11-3.209 11-3.219 11-3.215 11-3.217	4.66.128 35-1166 37-1040 35-1170 35-1179	11-3.223 11-3.239 11-3.271 11-3.259 11-3.265
4	4.00.235 SH. 1 ---------- 35-4199 SH. 1	SAN FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.55	30A 31A	11-3.31 11-3.35	4.00.234	11-3.205	4.66.170	11-3.231
5	4.00.235 SH. 2 ---------- 35-4199 SH. 2	SAN FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.57	31A	11-3.35	4.00.232 4.00.234	11-3.49 11-3.205	10-1310 4.66.170	11-3.243 11-3.231
6	4.00.235 SH. 3 ---------- 35-4199 SH. 3	SAN FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.59	N.A.	N.A.	Refer to ATCS Manual			
7	4.00.238 ---------- PEPS-32713-C SH. 3	INTERCONNECT CABLING DIAGRAMS	11-3.61	N.A.	N.A.	Refer to ATCS Manual			

Table 11-3.3 COMMUNICATIONS SYSTEM – SIWD LIST (cont'd)

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	REFERENCES					
				FROM IWD		TO ECBS		TO ECBCL	
				SHEET #	Page #	FILE #	Page #	FILE #	Page #
8	4.00.745	WIRING DIAGRAM SWITCH RADIO	11-3.63	31A	11-3.35	4.00.000 SH. 34 4.00.000 SH. 34A	11-3.201 11-3.203	4.94.360	11-3.241
9	4.92.310 SH. 1 ---------- 28846134 SH. 1	BOX-CODE CONTROL	11-3.65	27D 45	11-3.27 11-3.41	Refer to ATCS Manual			
10	4.92.310 SH. 2 ---------- 28846134 SH. 2	BOX-CODE CONTROL	11-3.67	N.A.	N.A.	Refer to ATCS Manual			
11	4.92.310 SH. 3 ---------- 28846134	ENGINEERING PARTS LIST	11-3.69	N.A.	N.A.	Refer to ATCS Manual			

The wires represented in each SIWD diagram are identified exactly as they appear in the Vehicle.

Each SIWD diagram depict the circuits as the appear with no power applied, unless specifically noted otherwise.

Since the System's Interfaces are represented in the BREDA Integrated Wiring Diagrams itselves, the SIWD diagrams don't include the (System) Integrated Wiring Diagrams on which the interfaces of the Subsystems are represented.

SIWD Diagrams are produced by TCS, MOTOROLA and VAPOR and are provided with an alphanumerical grid to allow cross referencing with other SIWDs or with IWD Diagrams or with ECBSs / ECBCLs as indicated in the above Table, columns "REFERENCES".
In addition, the following cross references are provided on each SIWD:

- **Wire continuation on multiple SIWD Sheet (Not Applicable)**

- **Reference to IWD**

The following references are provided:

- Incoming (from IWD) Wire Identification.
- References to IWD Sheet.
- Specific Equipment(s) Co-ordinates (in IWD).

For example, with reference to DWG BCF 4.00.233 sh. 2 (T.C.S. file # 35-4161 sh. 2), the above references are presented in the following way:

Go to location B8, refer to Terminal Board J2, pins 9, 23, 21, etc.

"To DWG 4.00.000
SH. 31A (D5)"

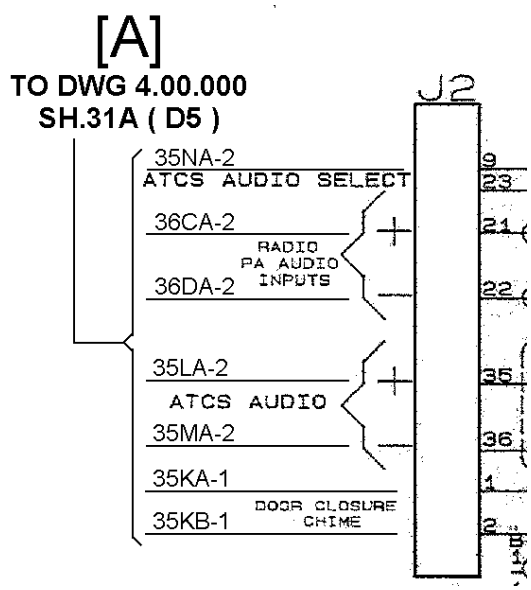
means: go to IWD Sheet 31A, (Equipment) in co-ordinates D5.

[A] indicates the Vehicle Body Sections (Where the Equipment is installed).

35NA-2, 36CA-2, etc. represent the Incoming Wire (from IWD 31A) Identification, where:

- 33, 36, etc. indicates the Control Circuit Identification Number.
- NA, CA, etc. is the two letter group that refers to the specific group.
- -2, indicates the wire segment.

For Wire Identification details refer to Section 11-1 para 11-1.12.1.



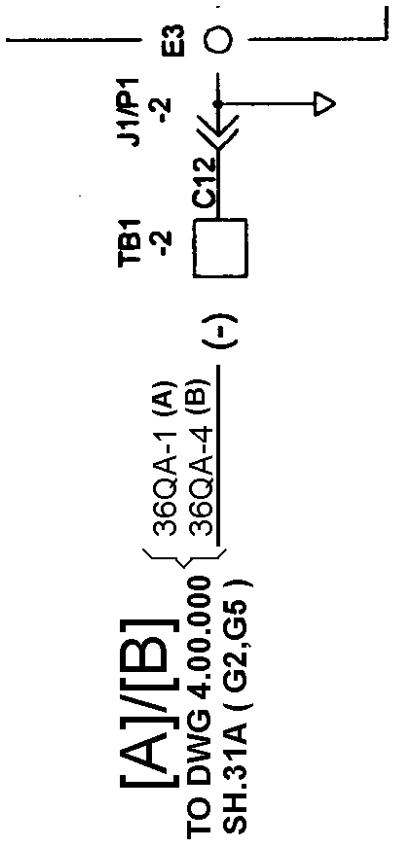
On the wire 35NA-2 the reference "ATCS AUDIO SELECT" provides information about the function / device of connection of the wire.

Refer to DWG BCF 4.00.232 (T.C.S. file # 10-4307).

This DWG refers to both Passenger Intercom Units installed in “A” and “B” Body Sections.

Go to location B8, refer to Terminal Board TB1, pin 2.

“To DWG 4.00.000
SH. 31A (G2, G5)” means: go to IWD Sheet 31A (Equipment) in co-ordinates G2, G5.



[A]/[B] indicates that Equipment are installed on both Vehicle Body Sections.

36QA-1, 36QA-4 represent the Incoming Wire (from IWD 21E) Identification, where:

- -36 indicates the Control Circuit Identification Number.

QA is the two letter group that refers to the specific group.

- -1, -4 indicate the wire segment.

For Wire Identification details refer to Section 11-1 para 11-1.12.1.

(A) or (B) at the end of the Incoming Wire Identification represent the Body Section on which the Equipment is installed and therefore which Wire Identification is applicable (i.e.: for Passenger Intercom Unit installed on “A” Body Section, the Incoming Wire is 36QA-1).

C12 represent the T.C.S. Wire Identification # in the Sub-system

J1/P1 represent the Connector Code in the Sub-system

-2 is the specific pin

E3 is the pin of the device slot

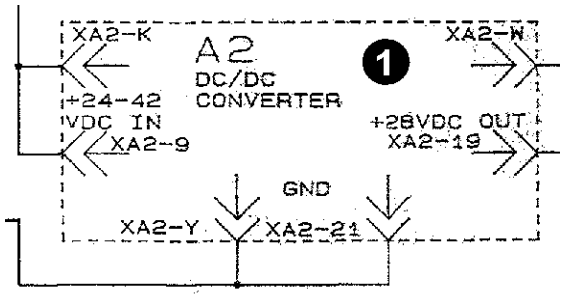
- **Reference to IWT (Not Applicable)**

- **Reference to ECBS**

Circuit boards are represented on the T.C.S. drawings by dashed blocks.

In function of the complexity of the drawing, and in order to highlight the references, the references are represented as indicated in the following examples:

1) The drawing available area to include the reference - note is small with respect to the reference.



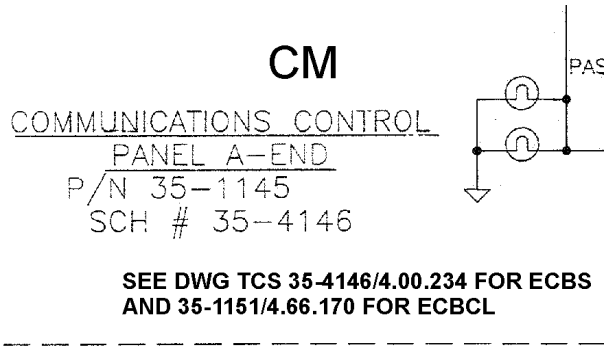
Refer to DWG BCF 4.00.233 Sh. 1:
Go to location G7.
The card represented is the DC to DC Converter (A2).

In the dashed block, a black spot with identification number (i.e. 1) is provided.

The corresponding note,
(i.e. 1 SEE DWG TCS 35-4008 FOR ECBS AND 35-1018/4.66.171 FOR ECBCL)

provided in a suitable area of the drawing, next to the relevant Circuit Board, indicates to refer to DWG T.C.S. 35-4008 for the ECBS of the DC to DC Converter (A2).

2) The drawing available area to include the reference - note is suitable with respect to the reference.



Refer to DWG BCF 4.00.235:
Go to location B7.

The card represented is that of the Communication Control Panel (CM)

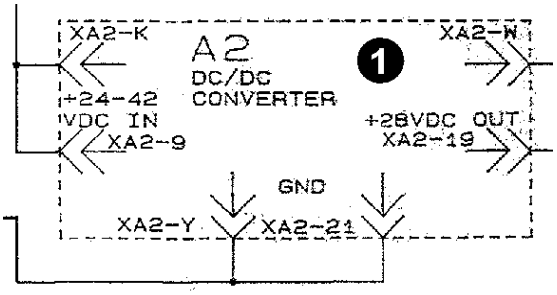
The note indicates to refer to DWG T.C.S. 35-4146 for ECBS of the Communication Control Panel.

- **Reference to ECBCL**

  Circuit boards are represented on the T.C.S. drawings by dashed blocks.

  In function of the complexity of the drawing, and in order to highlight the references, the references are represented as indicated in the following examples:

  1) The drawing available area to include the reference - note is small with respect to the reference.



  Refer to DWG BCF 4.00.233 Sh. 1:
  Go to location G7.
  The card represented is the DC to DC Converter (A2).

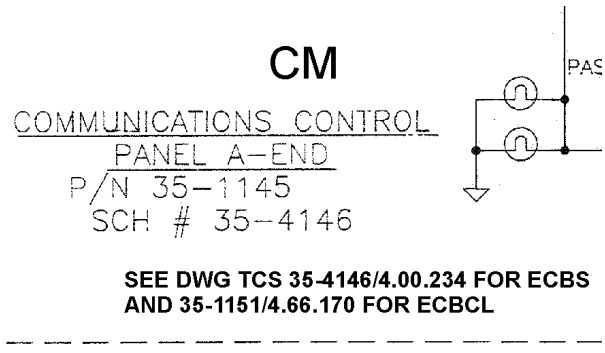
  In the dashed block, a black spot with identification number (i.e. ❶) is provided.

  The corresponding note,

  (i.e. ❶ **SEE DWG TCS 35-4008 FOR ECBS AND 35-1018/4.66.171 FOR ECBCL**)

  provided in a suitable area of the drawing, next to the relevant Circuit Board, indicates to refer to DWG T.C.S. 35-1018 for the ECBCL of the DC to DC Converter (A2).

  2) The drawing available area to include the reference - note is suitable with respect to the reference.



  Refer to DWG BCF 4.00.235:
  Go to location B7.

  The card represented is the Communication Control Panel (CM)

  The note indicates to refer to DWG T.C.S. 35-1151 for the ECBCL of the Communication Control Panel.

- **Reference to P&PD (Not Applicable)**

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		RELEASE	1	
	A	ADDED WIRE NOS. ADDED WIRE NOS TO DS1-2	2/1/93	
	B	ZN-5C, ADDED CR7, ZN-5A K2 NC CONTACT WAS TO R5 WIPER. R1 WAS TO C9, C2, R2, U1 PIN 14	4/27/93	
	C	ZN-5C R3 WAS 390K; ZN-4C R2 WAS 47K; ZN-4D R13 WAS 12K ZN-7D CR4 WAS 1N5226A	10/28/93	
	D	ZN-6C C11 WAS 50V, ZN-7C C5 WAS 50V, ZN-7B C6 WAS 25V, ZN-6B C13 WAS 25V, ZN-5B C10 WAS 25V, ZN-3C C8 WAS 50V.	7/1/93	
	E	R3 WAS 100K; R17 WAS 24K; R23 WAS 9.1K	7-27-94	

[A]/[B] TO DWG 4.00.000 SH.31A (G2,G5) — 36RA-1 (A), 36RA-4 (B) — (+28V) — TB1-1, J1/P1-1, C11, E1

(CALL) S1 — C, NO

DS1 (CALL) — C681, E2

LS1 — C682, E4; C683, E5

K1 — CR3 1N4007 — Q1 2N2222A — CR4 1N5221B — R11 10K — R12 2K — CR6 1N5231A — C12 1.0 50V

R13 6.2K

C11 47, 50V

CR7 1N4007

CR5 1N4007

K2

C18 1.0 50V — R18 1K — R17 59K — C3, 47pF — R3 249K — C16 .1

C7 .047 — R16 27K — C14 .047 — R15 10K

R19, 47 — C17, .01 — C5, 47, 63V

C15 .1 — R20 430K — R22 47K — Q3 VCR4N (D, G, S) — R5 10K

R14 1K — R6 27K — R7 20K — C6 10 100V

1/4U1

R9 50K — R10 8.2K — R8 4.7K — C9 .1 — C2 47pF — R2 12K — C1 1.0 50V

Q2 2N3906 — R24 680K — R21 4.7K — R4 1K — R1 1.0K 1/2W

C13 6.8 50V — R23 6.2K — R25 430K — C10 6.8 50V — C4 1.0 50V

T1 — 300 Ω — 300 Ω

CR2 1N4136A — C8 10 100V — CR1 1N4007

E6 — J1/P1-3, TB1-3, C3 — E7 — J1/P1-4, TB1-4, C4

TB1-5 — ET085-2 (A), ET085-1 (B) (CT/L) ET084-2(A), ET084-1(B) — [A]/[B] TO DWG 4.00.000 SH.31A (G2,G5)

[A]/[B] TO DWG 4.00.000 SH.31A (G2,G5) — 36QA-1 (A), 36QA-4 (B) — (-) — TB1-2, J1/P1-2, C12, E3

A1: PASSENGER INTERCOM PCB,10-1310-101

SEE DWG TCS 10-1310 FOR ECBCL

REFERENCE DES	DESIGNATION LAST USED	CHART NOT USED
A1 .K	2	
A1 .CR	7	
A1 .Q	2	
A1 .U	1	
A1 .T	1	
A1 .R	25	
A1 .C	18	
A1 .E	7	
S	1	
DS	1	
LS	1	
TB	1	
J	1	

P/N LM224N

ALL RESISTORS IN OHM, 5%, ¼W. CAPACITOR IN MFD.

NOTES: UNLESS OTHERWISE SPECIFIED.

CONT N	A 309	BREDA COSTRUZIONI FERROVIARIE	
TYPE	R 07	SHEET	
FILE N	4.00.232		

11-3.49

DASH	DASH	DASH	DASH	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
QTY REQD PER ASSY					PARTS LIST / LIST OF MATERIAL			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
.X DECIMAL ±
.XX DECIMAL ±
.XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

DRAWN
CHECKED
APPROVAL
APPROVAL
APPROVAL
CUST. APPROVAL
CONTRACT NO.

10 1305
DASH NEXT ASSY
APPLICATION

TRANSIT CONTROL SYSTEMS

TITLE: SCHEMATIC PASSENGER INTERCOM UNIT

SIZE D | CODE IDENT NO. | 10-4307 | REV. E

SCALE ——— | SHEET 1 OF 1

LINK 4161-02D.SCH

REVISIONS			
REV	DESCRIPTION	DATE	APPR
-	INITIAL RELEASE	2-93	BC
A	REVISED SHIELDING AT J1 & J2.	7-93	BB
B	KCIB & KCIA WAS KCICB & KCICA.	4-93	BC
		3-94	BC
C	A1 AND A2 WERE TRANSPOSED		
D	SHT 1: R4 AND R5 WERE 2.5K; SHT 2: ADDED TB1 CONNECTIONS; XA3-18 WAS XA3-21 AND VISA-VERSA; XA3-19 WAS XA3-22 AND VISA-VERSA	9-94	BC
E	DELETED J4-34 AND 35, CONNECTED J4-3 AND 5, CONNECTED XA3-10 TO J4-5 DELETED J3-34 AND 35, CONNECTED J3-3 AND 5, CONNECTED XA3-20 TO J3-5 SHT 2: XA5-N DID CONN TO J3-28 XA5-12 DID CONN TO J4-28, XA5-R DID CONN TO J3-22, XA5-14 DID CONN TO J4-22, XA5-18 DID CONN TO XA5-J XA5-19 DID CONN TO XA7-J	7-96	ALS
F	SHT 2: ADDED TD1 CITCUIT; XA5-18 WAS XA5-19, XA5-19 WAS XA5-18, XA5-R WAS XA5-N, XA5-14 WAS XA5-12, XA5N WAS XA5-R, XA5-12 WAS XA5-14 (ENG CORR)	1/97	ALS

(A-END)

[A] TO DWG 4.00.000 SH.31A (E5)

+37.5V CAR POWER — S43-3 — NB43-1 — CAR POWER RTN

J2 — J1 — J3

(TEST ONLY)

+37.5V CAR POWER — CAR POWER RTN — +28V P.S.

E1 GND — (AAR TRAY) — (PA CONTROL BOX)

(B-END)

J4

34AA-1 +28V

34BA-1 +28V KS POWER

34CA-1 GND

34DA-1 CAB INTERCOM SELECT

34EA-1 CAB INTERCOM LAMP

34HA-1 PASS P.A. SELECT

34JA-1 PASS P.A. LAMP

34FA-1 PASS INTERCOM SELECT

34GA-1 PASS INTERCOM LAMP

34WA-1 LAMP TEST (TEST ONLY)

[A] TO DWG 4.00.000 SH.31A (D6,E6)

A2 DC/DC CONVERTER ❶

XA2-K +24-42 VDC IN XA2-9

XA2-M +28VDC OUT XA2-19

XA2-Y GND XA2-21

+28V — DS1 POWER ON (GRN)

❹

XA3-20 — KA — KS — KB — XA3-10

KCIA — KCIB

PART OF A3: CAB IC CONTROL BD

XA3-3 — XA3-2 — KCICA — KCICB — XA3-M — XA3-5 — XA3-4

❷

XA5-E — XA5-F — KPPA — KRPA — PPAA (SHT2) — PPAB (SHT2) — TO KPA COIL (SHT 2) — (9-26VDC 720 OHM)

XA5-9 — XA5-10 — XA5-K — XA5-S — XA5-15

PART OF A5: PA COMM CONTROL BD

❺

+28V — XA4-1 — XA4-2 — XA4-R — IN — FLASHER — OUT — XA4-3 — KPIC

PIC CHIME GEN. SELECT (SHT2)

XA4-U — XA4-W — XA4-V — XA4-X — KPIR — +28V — +EDGE TRIG T.D. — OUT — IN — KPI

XA4-21 — XA4-22

PART OF A4: PIC CONTROL BD

34AB-2 +28V

34BB-2 +28V KS POWER

34CB-2 GND

[A] TO DWG 4.00.000 SH.31A (E5)

34DB-2 CAB INTERCOM SELECT

34EB-2 CAB INTERCOM LAMP

34HB-2 PASS P.A. SELECT

34JB-2 PASS P.A. LAMP

[A] TO DWG 4.00.000 SH.31A (E5)

34NB-2 PASS INTERCOM SELECT

34GB-2 PASS INTERCOM LAMP

[A] TO DWG 4.00.000 SH.31A (E5)

34WB-2 LAMP TEST (TEST ONLY)

[A] TO DWG 4.00.000 SH.31A (D5)

[A] TO DWG 4.00.000 SH.31A (C5)

MOBILE DATA TERMINAL POWER A-END 35FA-1

PART OF A1: RADIO CONTROL/ CHIME GENERATOR BD

KDIRB — D10 — XA1-12 — XA1-17 — XA1-16

XA1-13 — XA1-14 — JW1

XA1-L — XA1-J — XA1-Y — XA1-Z — XA1-X

25K CW R4 — 25K CW R5 — 3.3K — 3.3K

XA1-K — XA1-H — XA1-15 — XA1-16

❸

35GA-2 MOBILE DATA TERMINAL POWER B-END 35HA-1

[A] TO DWG 4.00.000 SH.31A (C5)

J2 — J1 — J4

36FA-1 LON MICOM

36EA-1 MICP GX

36HA-1 DTM-IN

36BA-2 TMB 5-DCC A

[A] TO DWG 4.00.000 SH.31A (D6)

RADIO POWER SUPPLY

36AA-2 — NB43-2

[A] TO DWG 4.00.000 SH.31A (E5)

DISPATCHER RADIO/PA SELECT — 36NA-2

[A] TO DWG 4.00.000 SH.31A (D6)

DISPATCHER RADIO/PA SELECT. (TEST ONLY)

LAMP TEST (TEST ONLY)

DIRECTION T/L — 36RB-2

[A] TO DWG 4.00.000 SH.31A (E5)

❶ SEE DWG TCS 35-4008 FOR ECBS AND 35-1018/4.66.171 FOR ECBCL

❷ SEE DWG TCS 35-4167/4.00.265 FOR ECBS AND 35-1166 FOR ECBCL

❸ SEE DWG TCS 35-4162/4.00.266 FOR ECBS AND 35-1159/4.66.128 FOR ECBCL

❹ SEE DWG TCS 35-4180/ FOR ECBS AND 35-1179 FOR ECBCL

❺ SEE DWG TCS 35-4171 FOR ECBS AND 35-1170 FOR ECBCL

POWER & CONTROL CIRCUITS

RELAY	FUNCTION
KS	TRANSFER SWITCH ON (LEAD CAR)
KA	A-END TRANSFER SWITCH (LEAD CAR)
KB	B-END TRANSFER SWITCH (LEAD CAR)
KPI	PASSENGER INTERCOM
KPIC	PASSENGER INTERCOM CALL
KPIR	PASSENGER INTERCOM RELEASE
KPTT	PASSENGER INTERCOM PUSH-TO-TALK
KCIA	CAB INTERCOM (A-END)
KCIB	CAB INTERCOM (B-END)
KCICA	CAB INTERCOM (A-END)
KCICB	CAB INTERCOM (B-END)
KPPA	PASSENGER PUBLIC ADDRESS
KRPA	RADIO PUBLIC ADDRESS
KDIRB	B-END DIRECTION T/L
KDCC	DOOR CLOSURE CHIME
KPA	PUBLIC ADDRESS
KMC	INTERCOM MONITOR SPEAKER CHIME
KATCS	ADVANCED TRAIN CONTROL SYSTEM
KPTTA	INTERCOM PUSH-TO-TALK (A-END)
KPTTB	INTERCOM PUSH-TO-TALK (B-END)

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R97
MATR./FILE 4.00.233 TAV./SHEET 001
DES. ARCH./FILE SECTION DDP
FASE PROG./DESIGN STAGE
COMP. TAVOLI / EQUALITES

NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER FILE DISK.

		DRAWN B.LECHNER 9/28/92	TRANSIT CONTROL SYSTEMS TUSTIN, CALIFORNIA
		CHECKED	TITLE: SCHEMATIC- COMMUNICATION AMPLIFIER & CONTROL UNIT
		APPROVED	
	35-1160	CUST. APPROVAL J. KIEL	SIZE D — DWG NO. 35-4161 — REV F
DASH	NEXT ASSY	CONTRACT NO.	SCALE: NONE — SHEET 1 OF 2
APPLICATION			

11-3.51

REVISIONS			
REV	DESCRIPTION	DATE	APPR
	SEE SHT 1.		

1 SEE DWG TCS 35-4180 FOR ECBS AND 35-1179 FOR ECBCL

2 SEE DWG TCS 37-4041 FOR ECBS AND 37-1040 FOR ECBCL

3 SEE DWG TCS 35-4171 FOR ECBS AND 35-1170 FOR ECBCL

4 SEE DWG TCS 35-4162/4.00.266 FOR ECBS AND 35-1159/4.66.128 FOR ECBCL

5 SEE DWG TCS 35-4167/4.00.265 FOR ECBS AND 35-1166 FOR ECBCL

6 SEE DWG TCS 35-4162/4.00.266 FOR ECBS AND 35-1159/4.66.128 FOR ECBCL

7 SEE DWG TCS 35-4167/4.00.265 FOR ECBS AND 35-1166 FOR ECBCL

[A] TO DWG 4.00.000 SH.31A (D5)

[A] TO DWG 4.00.000 SH.31A (D6)

[A] TO DWG 4.00.000 SH.31A (D5)

[A] TO DWG 4.00.000 SH.31A (D5)

[A] TO DWG 4.00.000 SH.31A (E5)

[A] TO DWG 4.00.000 SH.31A (D5)

[A] TO DWG 4.00.000 SH.31A (D6)

PART OF A4: PIC CONTROL BD

PART OF A3: CIC CONTROL BD

PART OF A1: RADIO CONTROL/ CHIME GENERATOR BD

PART OF A5: PA COMM CONTROL BOARD

DETAIL A A6 & A7 OFF BOARD TRANSISTORS (SEE LOWER RIGHT OF THIS SHEET)

TRANSIT CONTROL SYSTEMS

SIZE	DWG NO.	REV
D	35-4161	F
SCALE: NONE		SHEET 2 OF 2

11-3.53

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE	12/8/92	BB
A	ADDED KA & KRB RELAYS; ADDED NOTE 4.	12/30/92	BB
B	ADDED KDIRB CIRCUIT; DELETED KRB CIRCUIT; REVISED CONNECTOR PIN No'S; ADDED LAMPTEST WIRING; SHT 1: J1 WAS P1; ADDED (6) DIODES; SHT 2: ADDED NOTE 1 REF TO J2;	2-2-93	BB
C	(SHT 2) DELETED 2 EXT SPEAKERS. (SHT 3) P204 PIN 3 WAS B+. P204 PIN 15 ADDED "(MIC HI)".	3/11/93	BC
D	(SHT 3) ADDED SHIELD AT P204-12, P203-12 (A-END), P203-12 (B-END). RELAY CONTACTS KDIRB WERE KRB (4 PL)	6-17-93	B. BLEACHER
E	SHT 2 - KCIA WAS KCICA; KCIB WAS KCICB.	11-28-93	BC
F	SHT 2 - REVISED RELAY PICTORIAL IN BOTH A & B ENDS. SHT 3 - P204-A WAS (BATT GND); P204-B WAS (BATT HOT).	3-23-95	KRH
G	KRPA (SHT 3, ZN B4) WAS AT SHT 1, ZN B4	12/11/95	BC
H	DELETED TRANSFER SWITCH FROM J3 AND J4 SHT 2: ADDED KDCC CONTACTS TO CHIME GEN CIRCUIT, P/N 35-1160 WAS -104	6/12/96	ALS
J	ADDED RESET SWITCH, K5, TD1, "CAB IC RESET T/L" LINE	1/7/97	R.YATES

SIMILAR TO A-END COMMUNICATION CONTROL PANEL

BREDA COSTRUZIONI FERROVIARIE

PROGETTO / TYPE	R07
MATR. / FILE	4.00.235
TAV. / SHEET	001
SEZ. ANGH. / FILE SECTION	DDP
FASE PROG. / DESIGN STAGE	
EQUAGLIANZE / EQUALITIES	

CM

COMMUNICATIONS CONTROL
B-END
P/N 35-1145
SCH # 35--4146

SEE DWG TCS 35-4146/4.00.234 FOR ECBS
AND 35-1151/4.66.170 FOR ECBCL

11-3.55

CM

COMMUNICATIONS CONTROL
PANEL A-END
P/N 35-1145
SCH # 35-4146

SEE DWG TCS 35-4146/4.00.234 FOR ECBS
AND 35-1151/4.66.170 FOR ECBCL

CB

COMMUNICATIONS AMPLIFIER
& CONTROL UNIT
P/N 35-1160
SCH # 35-4161

4. SCHEMATIC DIAGRAM SHOWN ARE SIMPLIFIED. FOR DETAILS SEE INDIVIDUAL EQUIPMENT SCHEMATICS.
3. TRANSIENT SUPPRESSORS NOT SHOWN ON RELAY COILS.
2. ALL "C" DESIGNATED WIRES ARE CAR OR TRAINLINE CONNECTIONS.
(1) SUPPLIED BY OTHERS: TRANSFER SWITCHES SHALL BE INTERLOCKED BY CAR BUILDER (ONLY ONE SWITCH 'ON' IN THE TRAIN CONSIST AT A TIME).

NOTES: UNLESS OTHERWISE SPECIFIED

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NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER DISK FILE.

DASH | NEXT ASSY | APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMAL .X ±.1 .XX ±.03 .XXX ±.015
ANGLES ±30'
FRACTIONS ±1/16
HOLE DIAMETERS
.000/.125 +.004 -.001
.126/.250 +.005 -.001
.251/.500 +.006 -.001
.501/.750 +.008 -.001
.751/1.000 +.010 -.001
1.001/2.000 +.012 -.001
DO NOT SCALE DRAWING

DRAWN	KR HONIGMANN
DATE	11-17-92
CHECKED	
MECH ENG	
ELECT ENG	
PROD ENG	
CHIEF ENG	
CUST. APPROVAL	
CONTRACT NO.	

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE: SAN FRANCISCO MUNI FUNCTIONAL SCHEMATIC, COMMUNICATION SYSTEM

SIZE	CODE IDENT NO.		REV.
D		35-4199	J

SCALE 1/1 | PLOT SCALE: 1/1 | SHEET 1 OF 3

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
DATA/FILE 4.00.235 TAV./SHEET 002
REF. ARCH./FILE SECTION DDP
PHASE PROG./DESIGN STAGE DDP
USED ON 4 JOINT EQUIPMENT

1 SEE DWG TCS 35-4146/4.00.234 FOR ECBS AND 35-1151/4.66.170 FOR ECBCL

2 SEE DWG TCS 10-4307/4.00.232 FOR ECBS AND 10-1310 FOR ECBCL

TO RADIO (SHT 3)
SPKR HI 36DA-4
SPKR LO 36CA-4
[A] TO DWG 4.00.000 SH.31A (E6)
[A] TO DWG 4.00.000 SH.31A (D6)
[B] TO DWG 4.00.000 SH.31A (E3)
[B] TO DWG 4.00.000 SH.31A (D3)

RADIO SPEAKER
PA SPEAKERS
+28V
K1
INT.
ALL
EXT.
INTERCOM PUSH TO TALK (PTT)
GOOSENECK MICROPHONE
INTERCOM PTT LAMPS
LAMPTEST (SHT1)
CS
PRE AMP
CAB INTERCOM SPEAKER
VOLUME CONTROL
(PTT)
COMMUNICATION CONTROL PANEL A–END (CONT) CM
P/N: 35–1145 SCH: 35–4146

34KA-1 34LA-1 34MA-1 34NA-1 34PA-1 34QA-1 34RA-1 34SA-1 34TA-1
34KB-3 34LB-3 34MB-3 34NB-3 34PB-3 34QB-3 34RB-3 34SB-3 34TB-3
C43 C44 C45 C54 C53 C55 C56 C60 C61
C83 C84 C85 C94 C93 C95 C96 C100 C101

PPAA PPAB
KPTTA KCIA KPTTB KCIB
KA KB KPI KPTT KS KPIC KPIR VOLTAGE SENSE
KRPA KATCS KPPA KDCC KMC KPA
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 8/45
+28V 5W 24V 18V 70.7V 8 OHM

J2 J3 J4
TL3 TL4 PASSENGER INTERCOM TRAINLINES 600 ohms
MIC SPKR
PRE COMP LINE
CALL
CALL LIGHT
POWER SUPPLY
PASSENGER INTERCOM UNIT (2 PLCS) P/N: 35–1178 SCH: 10–4307
CI

TL5 TL6 CAB INTERCOM TRAINLINES 600 ohms
TL1 TL2 PA TRAINLINES 600 ohms
PA LEVEL INTERIOR
PA LEVEL EXTERIOR
CL
INTERIOR SPEAKERS (8 PLACES TYP)
CH
EXTERIOR SPEAKERS

ATCS AUDIO
DOOR CLOSURE CHIME CONTACT
ATCS AUDIO SELECT CONTACT
FROM KPPA COIL (SHT 1)
SINGLE TONE CHIME
ASTABLE TONE CHIME
CHIME GEN
CB
COMMUNICATION AMPLIFIER & CONTROL UNIT
P/N: 35–1160 SCH: 35–4161

11-3.57
CODE IDENT NO. 35–4199 REV. J
1/1 SHEET 2 OF 3

POWER AND CONTROL CIRCUITS	
RELAY	FUNCTION
KI	COMM CONTROL PANEL POWER ON
KS	TRANSFER SWITCH ON (LEAD CAR)
KA	A-END TRANSFER SWITCH (LEAD CAR)
KB	B-END TRANSFER SWITCH (LEAD CAR)
KPI	PASSENGER INTERCOM
KPIC	PASSENGER INTERCOM CALL
KPIR	PASSENGER INTERCOM RELEASE
KPTT	PASSENGER INTERCOM PUSH-TO-TALK
KCIA	CAB INTERCOM (A-END)
KCIB	CAB INTERCOM (B-END)
KCICA	CAB INTERCOM CALL (A-END)
KCICB	CAB INTERCOM CALL (B-END)
KPPA	PASSENGER PUBLIC ADDRESS
KRPA	RADIO PUBLIC ADDRESS
KDCC	DOOR CLOSURE CHIME
KPA	PUBLIC ADDRESS
KMC	INTERCOM MONITOR SPEAKER SHIME
KATCS	ADVANCED TRAIN CONTROL SYSTEM
KPTTA	INTERCOM PUSH-TO-TALK (A-END)
KPTTB	INTERCOM PUSH-TO-TALK (B-END)
KDIRB	B-END DIRECTION T/L

CP

CAR RADIO POWER (LVDC) — RADIO POWER SUPPLY (IN +/−, OUT +/−)

SYNTOR RADIO

CR

P204: A+ (+13.6 VDC) B; A− (−13.6 VDC) A; PTT REF 8; SW B+ 22; SW +B 3; CHASSIS 9; B− 11; DET AUDIO (DISC AUDIO) 20; XMIT AUDIO (MIC HI) 15; SHIELD (RADIO GND) 1; SQUELCH 19; VOLUME 2; SPKR HI 21; SPKR LO 17; PL SELECT (DISPATCHER PA) 10; F1 4; F2 14; F3 13; F4 5; PTT 16

ANTENNA

CA

C260 C261 C263 C264 C266 C267 C268 C269 C270 C271 C272 C273 C274 C275

SPKR HI
SPKR LO
— TO CCP (SHT2)

P203

DISPATCHER PA	1
FREQ 1	4
FREQ 2	5
FREQ 3	11
FREQ 4	10
RADIO PTT	19
XMTR AUDIO	15
DISC AUDIO	12
RADIO GND	3
RADIO PTT RTN	14

CK

MOBILE DATA TERMINAL MOUNTING TRAY A-END

COMMUNICATION AMPLIFIER & CONTROL UNIT

CB

J2: 30 33 31 32 21 22 23 34

KRPA (9-26 VDC 720 OHM)

3.3K 3.3K 25K 25K

SQUELCH CONTROL

RADIO VOLUME

RADIO/PA AUDIO (SHT2)

J2: 28 29

P201: 13.6V 1; GND 2

C181 C182

KDIRB KDIRB KDIRB KDIRB

J2: 26 27

C211 C212

P203

1	DISPATCHER PA
4	FREQ 1
5	FREQ 2
11	FREQ 3
10	FREQ 4
19	RADIO PTT
15	XMTR AUDIO
12	DISC AUDIO
3	RADIO GND
14	RADIO PTT RTN

CK

MOBILE DATA TERMINAL MOUNTING TRAY B-END

P201: 1 13.6V; 2 GND

C110 C111

SOUND POWERED PHONE SYSTEM

BREDA COSTRUZIONI FERROVIARIE

PROGETTO/TYPE ROF

MATR./FILE 4.00.235 TAV./SHEET 003

SEZ. ARCH./FILE SECTION DDP

FASE PROG./DESIGN STAGE

UGUAGLIANZE / EQUALITES

11-3.59

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NOTE
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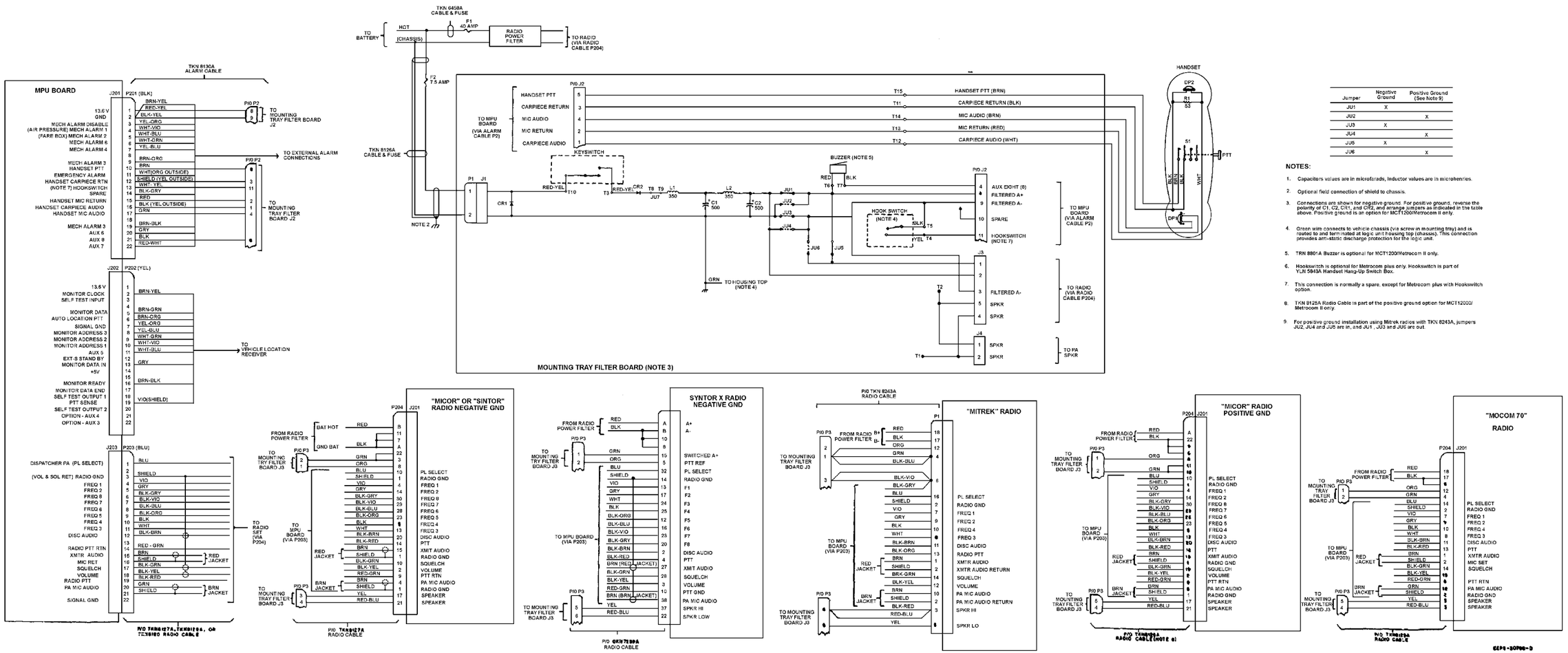
SIZE	CODE IDENT NO.		REV.
D		35-4199	J
SCALE 1/1	PLOT SCALE: 1/1	SHEET 3 OF 3	



Jumper	Negative Ground	Positive Ground (See Note 9)
JU1	X	
JU2		X
JU3	X	
JU4		X
JU5	X	
JU6		X

NOTES:

1. Capacitors values are in microfarads, Inductor values are in microhenries.
2. Optional field connection of shield to chassis.
3. Connections are shown for negative ground. For positive ground, reverse the polarity of C1, C2, CR1, and CR2, and arrange jumpers as indicated in the table above. Positive ground is an option for MCT1200/Metrocom II only.
4. Green wire connects to vehicle chassis (via screw in mounting tray) and is routed to and terminated at logic unit housing top (chassis). This connection provides anti-static discharge protection for the logic unit.
5. TRN 8801A Buzzer is optional for MCT1200/Metrocom II only.
6. Hookswitch is optional for Metrocom plus only. Hookswitch is part of YLN 5843A Handset Hang-Up Switch Box.
7. This connection is normally a spare, except for Metrocom plus with Hookswitch option.
8. TKN 8125A Radio Cable is part of the positive ground option for MCT1200/ Metrocom II only.
9. For positive ground installation using Mitrek radios with TKN 8243A, jumpers JU2, JU4 and JU5 are in, and JU1 , JU3 and JU6 are out.

CONT N	A 309	
TYPE	R 07	SHEET
FILE N	4.00.238	

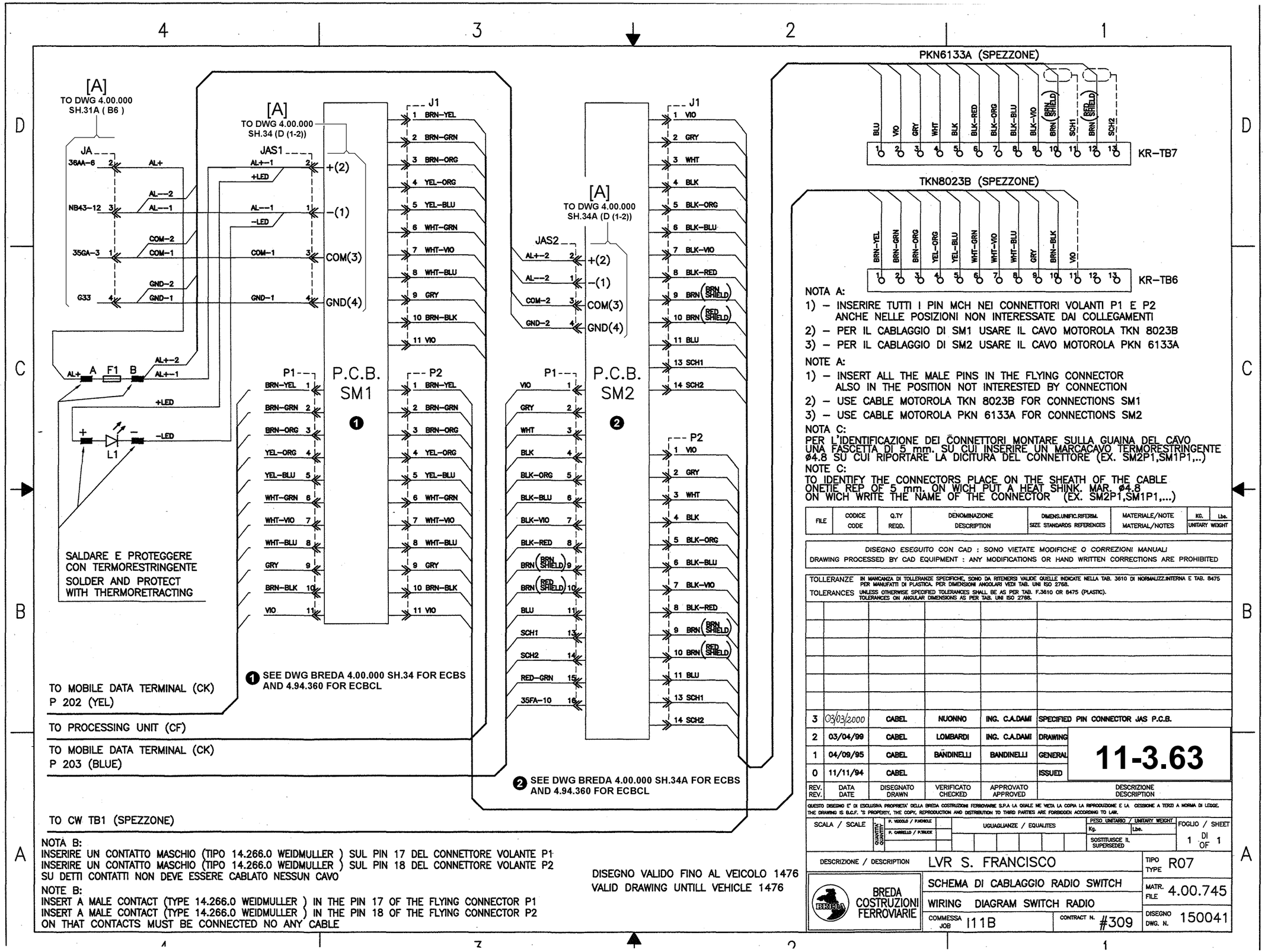
BREDA COSTRUZIONI FERROVIARIE

- SUPPLIER: MOTOROLA (MUNI)
- INTERCONNECT CABLING DIAGRAMS
- DWG. N° PEPS-32713-C (SH. 3/3)

Mobile Data Terminal
Interconnect Cabling Diagrams,
Filter Board Schematic Diagram
and Circuit Board Detail,
and Parts Lists
Motorola No. PEPS-32713-C
(Sheet 3 of 3)
11/19/84-PHI

MAINTENANCE

11-3.61



NOTA A:
1) – INSERIRE TUTTI I PIN MCH NEI CONNETTORI VOLANTI P1 E P2 ANCHE NELLE POSIZIONI NON INTERESSATE DAI COLLEGAMENTI
2) – PER IL CABLAGGIO DI SM1 USARE IL CAVO MOTOROLA TKN 8023B
3) – PER IL CABLAGGIO DI SM2 USARE IL CAVO MOTOROLA PKN 6133A

NOTE A:
1) – INSERT ALL THE MALE PINS IN THE FLYING CONNECTOR ALSO IN THE POSITION NOT INTERESTED BY CONNECTION
2) – USE CABLE MOTOROLA TKN 8023B FOR CONNECTIONS SM1
3) – USE CABLE MOTOROLA PKN 6133A FOR CONNECTIONS SM2

NOTA C:
PER L'IDENTIFICAZIONE DEI CONNETTORI MONTARE SULLA GUAINA DEL CAVO UNA FASCETTA DI 5 mm. SU CUI INSERIRE UN MARCACAVO TERMORESTRINGENTE ø4.8 SU CUI RIPORTARE LA DICITURA DEL CONNETTORE (EX. SM2P1,SM1P1,..)

NOTE C:
TO IDENTIFY THE CONNECTORS PLACE ON THE SHEATH OF THE CABLE ONETIE REP OF 5 mm. ON WICH PUT A HEAT SHINK. MAR. ø4.8 ON WICH WRITE THE NAME OF THE CONNECTOR (EX. SM2P1,SM1P1,...)

NOTA B:
INSERIRE UN CONTATTO MASCHIO (TIPO 14.266.0 WEIDMULLER) SUL PIN 17 DEL CONNETTORE VOLANTE P1
INSERIRE UN CONTATTO MASCHIO (TIPO 14.266.0 WEIDMULLER) SUL PIN 18 DEL CONNETTORE VOLANTE P2
SU DETTI CONTATTI NON DEVE ESSERE CABLATO NESSUN CAVO

NOTE B:
INSERT A MALE CONTACT (TYPE 14.266.0 WEIDMULLER) IN THE PIN 17 OF THE FLYING CONNECTOR P1
INSERT A MALE CONTACT (TYPE 14.266.0 WEIDMULLER) IN THE PIN 18 OF THE FLYING CONNECTOR P2
ON THAT CONTACTS MUST BE CONNECTED NO ANY CABLE

DISEGNO VALIDO FINO AL VEICOLO 1476
VALID DRAWING UNTILL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	Kg.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	DESCRIZIONE DESCRIPTION
3	03/03/2000	CABEL	NUONNO	ING. C.A.DAMI	SPECIFIED PIN CONNECTOR JAS P.C.B.
2	03/04/99	CABEL	LOMBARDI	ING. C.A.DAMI	DRAWING
1	04/09/95	CABEL	BANDINELLI	BANDINELLI	GENERAL
0	11/11/94	CABEL			ISSUED

11-3.63

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

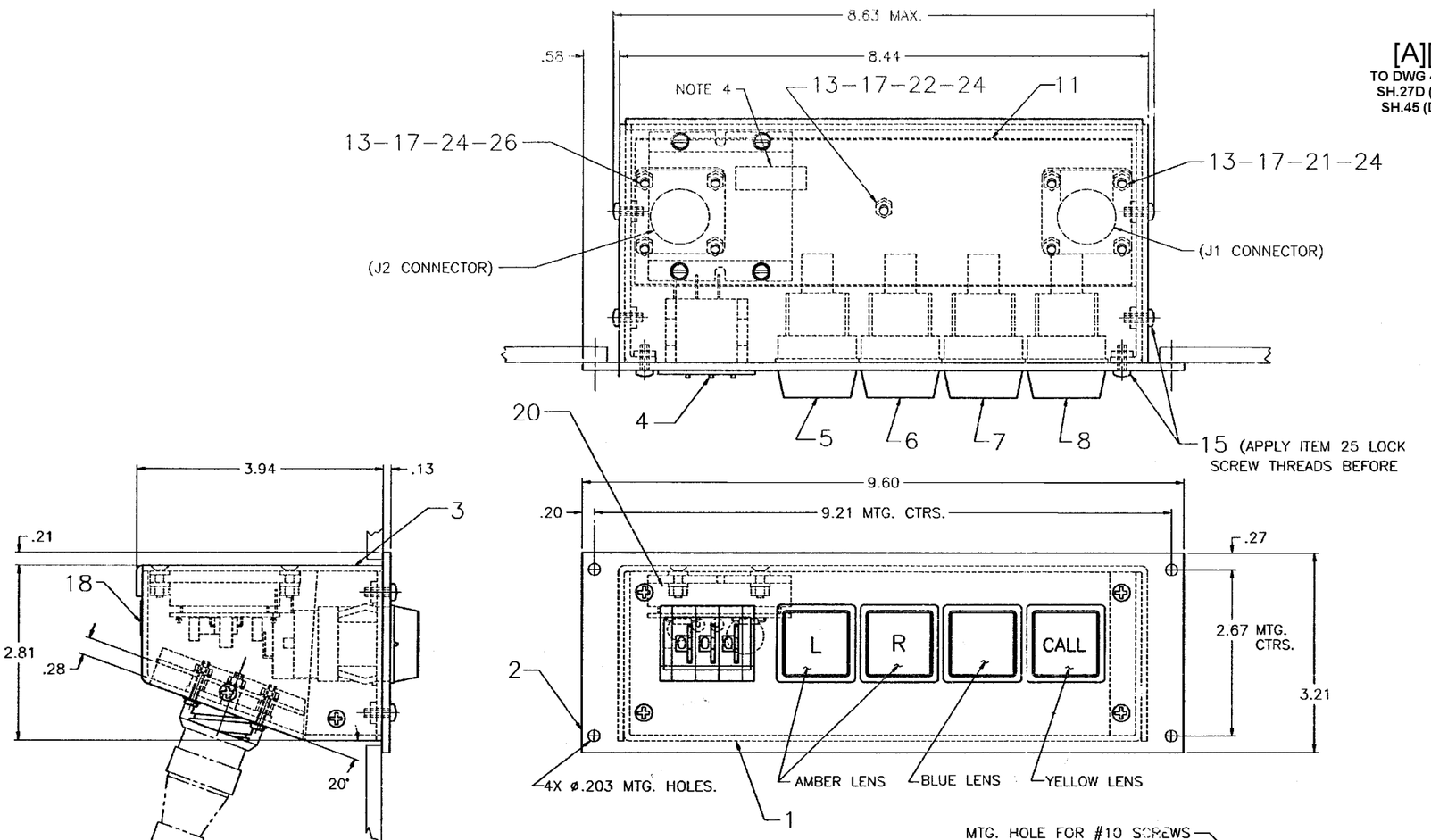
SCALA / SCALE
QUANTITY / QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK
UGUAGLIANZE / EQUALITIES
PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.
SOSTITUISCE IL SUPERSEDED
FOGLIO / SHEET 1 DI OF 1

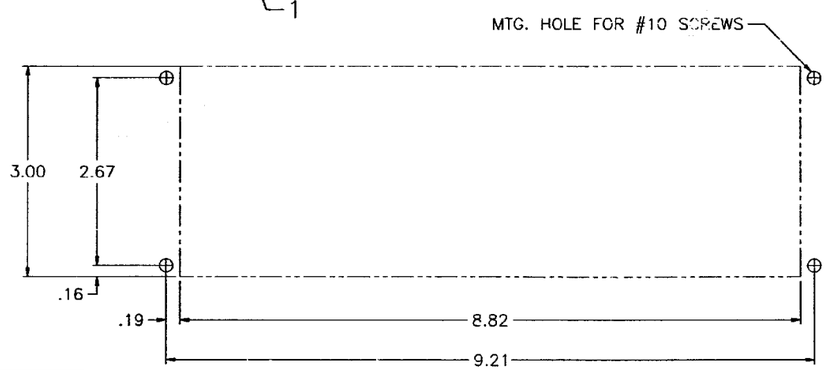
DESCRIZIONE / DESCRIPTION: LVR S. FRANCISCO
SCHEMA DI CABLAGGIO RADIO SWITCH
WIRING DIAGRAM SWITCH RADIO

BREDA COSTRUZIONI FERROVIARIE

COMMESSA JOB I11B
CONTRACT N. #309

TIPO TYPE R07
MATR. FILE 4.00.745
DISEGNO DWG. N. 150041





PANEL MTG. CUTOUT

GENERAL NOTES:

1. ALL DIMENSIONS ARE REFERENCE ONLY.
2. MATERIAL REF.: BLACK ANODIZED ALUMINUM.

[A][B]
TO DWG 4.00.000
SH.27D (D2,D6)
SH.45 (D (2-8))

PIN OUTS

TRANSPONDER I/O CONNECTOR (J1)

PIN	FUNCTION
1	TRANSPONDER DATA BIT 1
2	TRANSPONDER DATA BIT 2
3	TRANSPONDER DATA BIT 3
4	TRANSPONDER DATA BIT 4
5	TRANSPONDER DATA BIT 5
6	TRANSPONDER DATA BIT 6
7	TRANSPONDER DATA BIT 7
8	TRANSPONDER DATA BIT 8
9	TRANSPONDER DATA BIT 9
10	TRANSPONDER DATA BIT 10
11	TRANSPONDER DATA BIT 11
12	TRANSPONDER DATA BIT 12
13	TRANSPONDER DATA BIT 13
14	TRANSPONDER DATA BIT 14
15	TRANSPONDER DATA BIT 15
16	TRANSPONDER DATA BIT 16
17	TRANSPONDER DATA BIT 17
18	TRANSPONDER DATA BIT 18
19	TRANSPONDER DATA BIT 19
20	NOT USED
21	NOT USED
22	VX (TRANSPONDER OVERLOOP OUTPUT SIGNAL)
23	POWER OUT TO TRANSPONDER (+24VDC)
24	GROUND OUT TO TRANSPONDER (B-)
25	NOT USED
26	NOT USED
27	NOT USED
28	NOT USED

CAR INPUT CONNECTOR (J2)

PIN	FUNCTION
1	B+ 37.5 VOLT INPUT <1 AMP
2	NOT USED
3	B-
4	CONTROLS BIT 19 (B+=HIGH)
5	SPARE, BIT 12 ACTIVE IN REAR OF CAR ONLY
6	SPARE, BIT 13 ACTIVE IN REAR OF CAR ONLY
7	SPARE, BIT 14 ACTIVE IN REAR OF CAR ONLY
8	SPARE, BIT 15 ACTIVE IN REAR OF CAR ONLY
9	SPARE, BIT 16 ACTIVE IN REAR OF CAR ONLY
10	SPARE, BIT 17 ACTIVE BOTH FRONT AND REAR
11	CONSIST END CAB (IF END"HIGH") (IF COUPLED "LOW")
12	CAR END, FRONT "HIGH" (75 MILLIAMPS), REAR "LOW" + TURN SIGNALS @ 1 AMP EACH
13	NOT USED
14	"LEFT" TURN SIGNAL OUTPUT
15	NOT USED
16	"RIGHT" TURN SIGNAL OUTPUT

NOTES: 1. ALL SPARE INPUTS ARE ACTIVE "HIGH" AT 4 MILLIAMPS EXCEPT PIN NUMBER 12 REQUIRING 75 MILLIAMPS + TURN SIGNAL (<1 AMP)

2. MOMENTARY TURN SIGNAL OUTPUTS PROVIDE VEHICLE B+ AT CONNECTOR PINS 14 AND 16 WHENEVER THE "L" OR "R" PUSHBUTTONS ARE DEPRESSED RESPECTIVELY. ANY TIMING AND/OR DISENGAGEMENT REQUIREMENTS ARE EXTERNAL TO THE C.C.B. AND ARE NOT IN VAPOR'S SCOPE OF SUPPLY. MAXIMUM OUTPUT CURRENT FOR EACH TURN SIGNAL OUTPUT IS 1 AMP.

3. "HIGH" REFERS TO VEHICLE 37.5 VDC (B+) SUPPLY. "LOW" REFERS TO "B-" OR OPEN CIRCUIT.

4. DIP SWITCH FOR SETTING VEHICLE I.D. NUMBER.

CONT N	A 309		BREDA COSTRUZIONI FERROVIARIE
TYPE	R 07	SHEET 1/3	
FILE N	492.310		

LET	DESCRIPTION	DATE	DRN	CHK	ENG
	REVISION				
M	ITEM 26 SPACER WAS ITEM 21: IN SHEET 2 THUMBWHEEL AND				
	CONN ASSY. CONN. J7 UNIT WAS HUNDREDS, CONN J9 HUNDREDS WAS UNIT				
	(ECN 821539026)	10b2/95	RF	WF	RU
L	ADDED DIM. 8.63 MAX. & ITEM 25. [ECN.821391005]	3/2/95	RM	WF	RU
K	REMOVED PRINTED CIRCUIT BOARD FROM ITEM 3 COVER ASSY. [ECN.821539001]	1/23/94	RM	WF	RU
H	ADDED PCB FOR -01 ONLY & 28826372 P.C. BOARD TO CONNECTION DIAG.;				
	RELOCATED ITEM 18; REMOVED ITEMS 28, 29, & 30. (ECN.833439015)	11/28/94	RJS	WF	RU
G	ADDED ITEM 28; REM,'D. ITEMS 14, 19, 23, 25, 26 & 27, ON SHT. 2 OF 2				
	REVISED POWER SUPPLY WIRES. ECN 829339069	11/12/93	AB	KRM	RWH

ASSOCIATED DRAWINGS

SCHEMATIC WIRING DIAGRAM	29503014
VAPOR TEST PROCEDURE	PSS-208-0024

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NEXT ASSY.

1. ± .9" UNLESS OTHERWISE SPECIFIED.
2. TOLERANCES XX ± .005" XX = ± .015" ANGLES ± 1/2° FRACTIONS = ± 1/64"
3. ALL DIMENSIONS SHOWN IN INCHES
4. DO NOT SCALE DRAWINGS, USE DIMENSIONS
5. THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI Y 14.5M
6. REMOVE BURRS & BREAK ALL SHARP EDGES
7. DISCLOSURES SHOWN HEREON ARE COVERED BY PATENTS ISSUED OR PENDING

DRAWN BY	R.GEVEROLA	1/29/93
CHECKED BY	KRM	1/29/93
ENG APVD.	MRW	1/29/93
MAT'L SPECS.		
MFG APVD.		

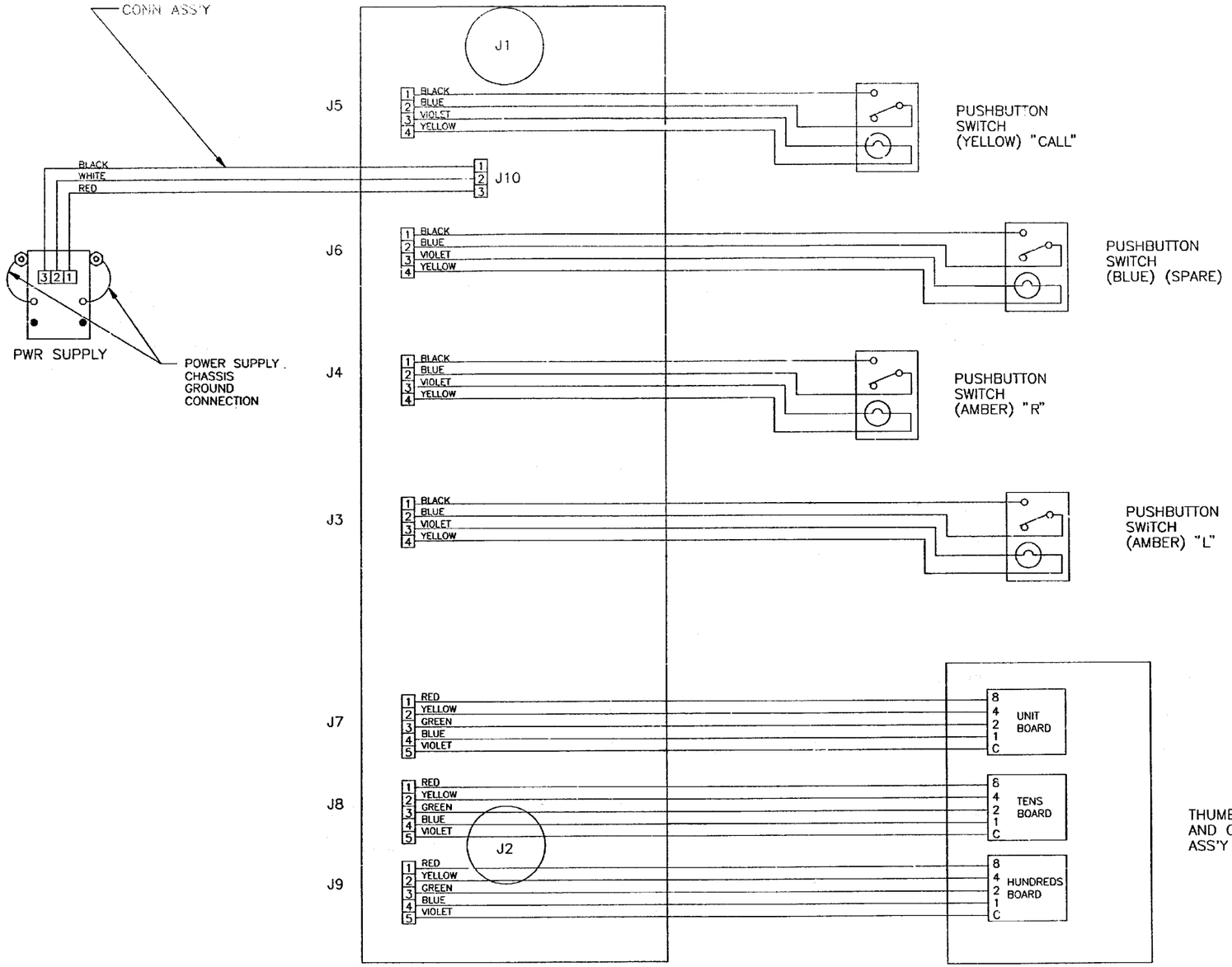
VAPOR
6420 West Howard Street
Niles, Illinois 60714
A Mark IV Industries Company

TITLE
BOX-CODE CONTROL

MRN. NO.	DWG. NO.	REV.
90014-6	28846134	M

FINISH		
SCALE	WEIGHT 2.1 LBS. MAX.	SHEET 1 OF 2

11-3.65



CONT N A 309 | TYPE R 07 | FILE N 4.92.310 | SHEET 2/3 | BREDA COSTRUZIONI FERROVIARIE

CONNECTION DIAGRAM

11-3.67

LET	DESCRIPTION	DATE	DRN	CHK	ENG
	REVISION				

ASSOCIATED DRAWINGS

1. +/- 5° UNLESS OTHERWISE SPECIFIED
2. TOLERANCES .XXX ± .005 .XX ± .015 ANGLES ± 1/2° FRACTIONS = ±1/64"
3. ALL DIMENSIONS SHOWN IN INCHES
4. DO NOT SCALE DRAWINGS. USE DIMENSIONS
5. THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI Y 14.5M
6. REMOVE BURRS & BREAK ALL SHARP EDGES
7. DISCLOSURES SHOWN HEREON ARE COVERED BY PATENTS ISSUED OR PENDING

DRAWN BY	AWS	8-12-93
CHECKED BY	KRM	8/12/93
ENG.APVD.	KRM	8/12/93
MATL.SPECS.		
MFG.APVD.		

NEXT ASSY.

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VAPOR
6420 West Howard Street
Niles, Illinois 60714
A Mark IV Industries Company

TITLE: BOX – CODE CONTROL

MRN. NO. 90014-6 | DWG. NO. 28846134 | REV. M

FINISH | SCALE | WEIGHT | SHEET 2 OF 2

Vapor, a Mark IV company
6420 Howard Street
Niles, IL 60714

Engineering Parts List
28846134 Rev K

Drawing.: 2884613400
Descrptn: CODE CONTROL BOX
Customer: S.F.MUNI/BREDA MRN: 90014-600 Initial Application:
Drn: RG 3/30/93 Chk: KRM 4/16/93 Eng Chk: KRM 4/16/93
Rev: K 10/02/95 Drn: RF Chk: WF Eng Chk: RU ECN: 821539026
Rev: H 3/02/95 Drn: RM Chk: Eng Chk: RU ECN: 821391005

Item	Part Number	Description	Quantity Per	U/M	Rev
1.00	29340339	BOX ASSY	1.000000	EACH	
2.00	29330338	COVER-FRONT	1.000000	EACH	
3.00	29331156	COVER ASSY	1.000000	EACH	D
4.00	29320341	SWITCH ASSY-THUMBWHEEL	1.000000	EACH	
5.00	29221099-04	SWITCH & CONN ASSY (L)	1.000000	EACH	
6.00	29221099-02	SWITCH & CONN. ASSY. (R)	1.000000	EACH	
7.00	29221099-05	SWITCH & CONN ASSY	1.000000	EACH	
8.00	29221099-06	SWITCH & CONN ASSY (CALL)	1.000000	EACH	
11.00	29530037	BOARD ASSY.-P.C.	1.000000	EACH	G
13.00	16910177-01	WASHER,INSULATING	9.000000	EACH	D
15.00	67121223-01	SCR PAN HD REC 6-32X.31	8.000000	EACH	
17.00	67122115-05	SCR PHD SLT NYL 4-40 X .75	9.000000	EACH	D
18.00	97521924-69	LABEL-IDENT.	1.000000	EACH	
20.00	29320762	CONNECTOR ASSY	1.000000	EACH	A
21.00	97110002-07	SPACER	4.000000	EACH	K
22.00	97110002-03	SPACER	1.000000	EACH	A
24.00	17110017-06	NUT HEX NYL 4-40	9.000000	EACH	D
25.00	67110007-01	ADHESIVE SCR LK ANAEROBIC		AR	H
26.00	97110002-04	SPACER	4.000000	EACH	K

end

CONT N	A 309		BREDA COSTRUZIONI FERROVIARIE
TYPE	R 07	SHEET 3/3	
FILE N	4.92.310		

S. 7590/A

11-3.69

11-3.5 Integrated Wiring Tables (IWT)

The COMMUNICATIONS SYSTEM Integrated Wiring Tables (IWT), (produced by BREDA) are provided, in the following pages, to complement the IWD circuits representation with specific wire(s) information/data for Fault(s) troubleshooting and Maintenance activities on (previously identified) faulty Equipment.
These Wire information/data, such as:
Cable Type, Wire Identification, Wire Connection, Pin Identification and Raceway Identification & Location, are provided for each Subassembly/Equipment listed (by BCF Equipment Identification Code, in alphabetical sequence) in the following Table 11-3.4.

Table 11-3.4 COMMUNICATIONS SYSTEM - IWT LIST

BCF EQUIP. IDENT CODE ---------- EQUIPMENT	EQUIPMENT / SUBASSEMBLY	FROM PAGE #	TO PAGE #	REFERENCES TO IWD			NOTE
				SHEET #	EQUIP. LOC.	PAGE #	
CA ---------- RADIO ANTENNA	RADIO ANTENNA	11-3.83	11-3.88	31A	C8, D7	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CB ---------- COMMUNICATION AMPLIFIER CONTROL UNIT	COMMUNICATION AMPLIFIER CONTROL UNIT	11-3.89	11-3.96	31A	(CDE)5	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CD ---------- RADIO SILENT ALARM SWITCH	RADIO SILENT ALARM SWITCH	11-3.97	11-3.102	31A	A7, C3	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CF ---------- SIGNPOST RECEIVER	SIGNPOST RECEIVER	11-3.103	11-3.106	31A	D8	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CH ---------- SPEAKER EXTERIOR	SPEAKER EXTERIOR	11-3.107	11-3.112	31A	A3, A6	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CI ---------- INTERCOMM. UNIT PASSENGER AREA	INTERCOMM. UNIT PASSENGER AREA	11-3.113	11-3.118	31A	G2, G5	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449

Table 11-3.4 COMMUNICATIONS SYSTEM - IWT LIST (cont'd)

BCF EQUIP. IDENT CODE ---------- EQUIPMENT	EQUIPMENT / SUBASSEMBLY	FROM PAGE #	TO PAGE #	REFERENCES TO IWD			NOTE
				SHEET #	EQUIP. LOC.	PAGE #	
CK ---------- MOBILE DATA TERMINAL	MOBILE DATA TERMINAL	11-3.119	11-3.128	31A	(AB)8, (BC)2	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CL ---------- INTERIOR SPEAKERS	INTERIOR SPEAKERS	11-3.129	11-3.146	31A	A2, A3, A4, A5	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CM ---------- COMMUNICATION CONTROL UNIT	COMMUNICATION CONTROL UNIT	11-3.147	11-3.152	30A	(BC)3, (BC)6	11-3.35	SEE SH. 30 (PAGE 11-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449
				31A	(DE)2, (DE)6	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CP ---------- RADIO POWER SUPPLY	RADIO POWER SUPPLY	11-3.153	11-3.156	31A	F8	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CR ---------- RADIO EQUIPMENT	RADIO EQUIPMENT	11-3.157	11-3.160	12D	C6	11-3.23	SEE SH. 12B (PAGE 11-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449
				31A	C8	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CV ---------- POWER LINE FILTER	POWER LINE FILTER	11-3.161	11-3.164	31A	D8	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
CW ---------- TERMINAL BOARD PANEL	TERMINAL BOARD PANEL	11-3.165	11-3.178	31A	E7, G7, F8, C7, D7, E6, E4, C3	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449
KE ---------- MAINTENANCE TELEPHONE JACK	MAINTENANCE TELEPHONE JACK	11-3.179	11-3.184	42C	B3,B4,B5,B6	11-3.39	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES # 1400, 1401, 1403, 1449
SM ---------- SWITCH RADIO	SWITCH RADIO	11-3.185	11-3.192	31A	(ABC)6	11-3.35	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449

Table 11-3.4 COMMUNICATIONS SYSTEM - IWT LIST (cont'd)

BCF EQUIP. IDENT CODE ---------- EQUIPMENT	EQUIPMENT / SUBASSEMBLY	FROM PAGE #	TO PAGE #	REFERENCES TO IWD			NOTE
				SHEET #	EQUIP. LOC.	PAGE #	
VE ---------- CODE CONTROL BOX (VETAG)	CODE CONTROL BOX (VETAG)	11-3.193	11-3.198	12C	C4, C8	11-3.21	SEE SH. 12A (PAGE 11-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449
				45	D(2-8)	11-3.41	
				27D	D2, D6	11-3.27	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449

Because the enter key of the IWT is the BCF Equipment Identification Code, the IWT are useful only for Fault(s) troubleshooting and maintenance activities on previously identified faulty Equipment.

The IWT don't include the specific wiring information/data pertaining to the SIWD, ECBS and ECBCL.

Refer to para 11-3.5.1 for COMMUNICATIONS SYSTEM Raceway Location and Identification.

Refer to para 11-3.5.2 for COMMUNICATIONS SYSTEM Integrated Wiring Tables.

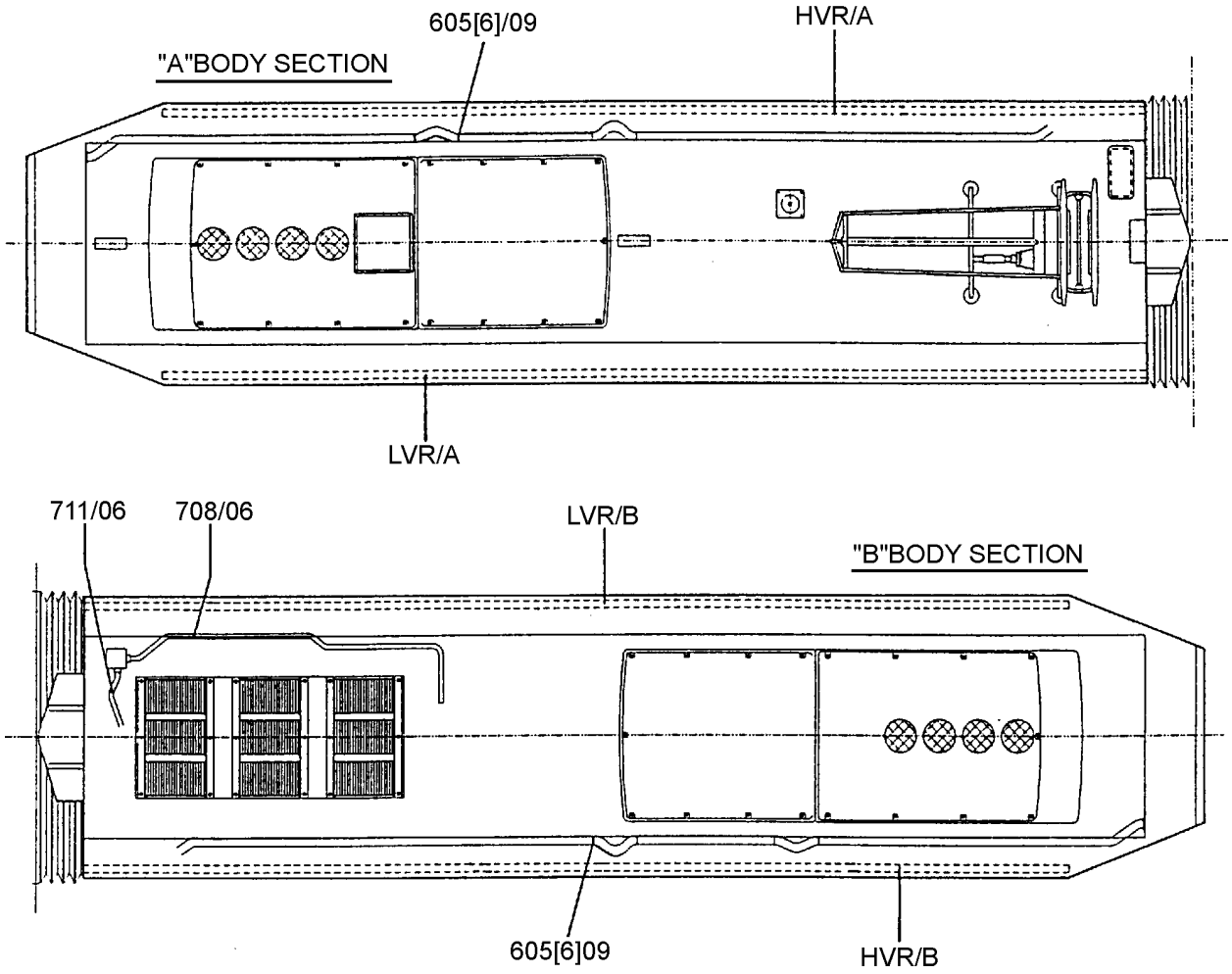
In the IWT Tables the symbol ♦ indicates that corresponding Cable/Wire is not housed in raceways.

This occurs in the following cases:

- Electronic Circuit Board to Electronic Circuit Board Connections.
- Terminal Board to Terminal Board Connections.
- Terminal Board to Relay Connections.
- Subsystem Internal Wiring.

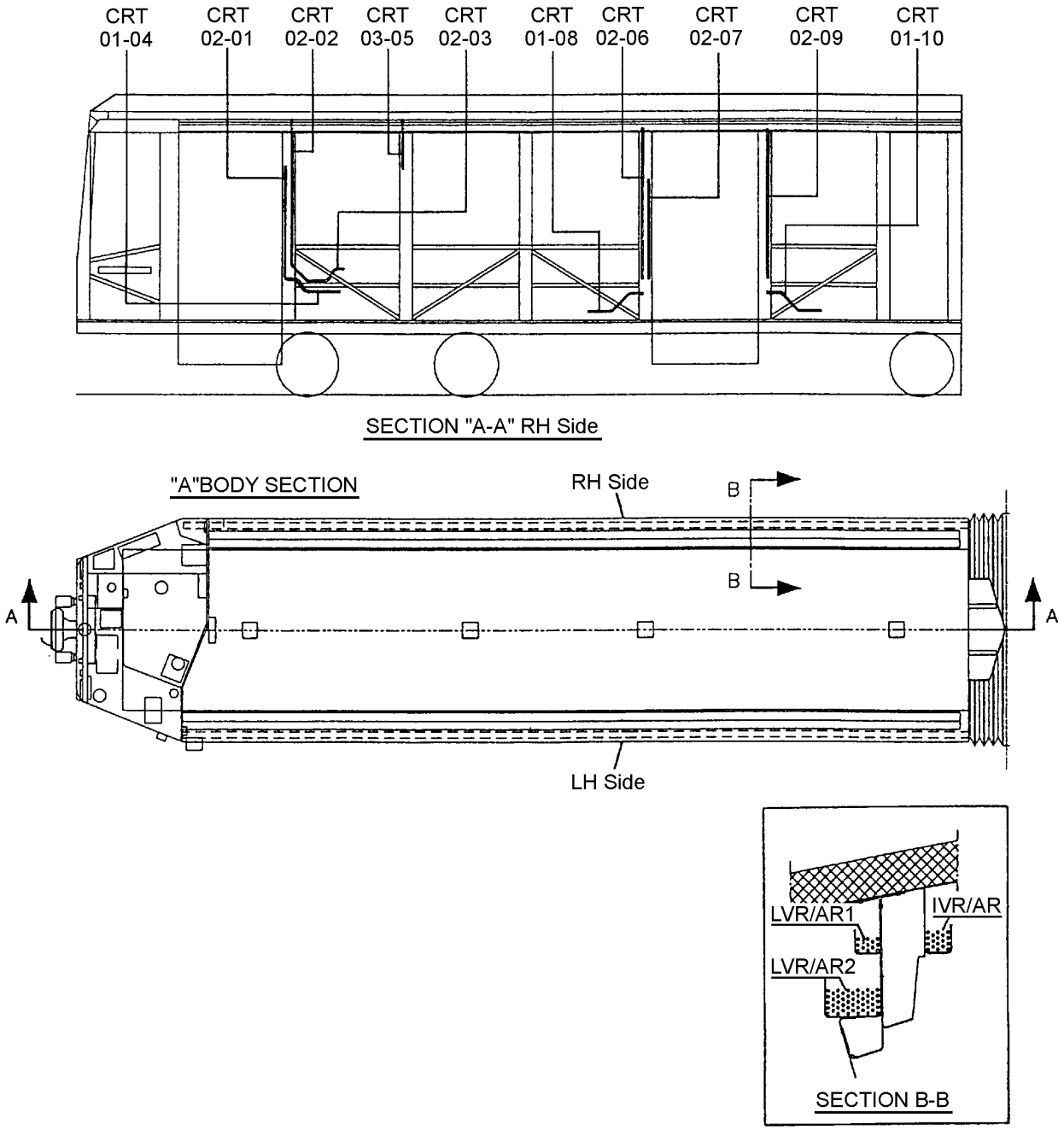
11-3.5.1 COMMUNICATIONS SYSTEM Raceway Identification

Figures 11-3.1 through 11-3.8 provide the COMMUNICATIONS SYSTEM Raceway Identification and Location Illustration (L.I.) Code consistent with those listed in the corresponding columns (RACEWAY) ID. and L.I. CODE provided in the relevant IWT (para 11-3.5.2).
Refer to Section 11-1, para 11-1.14.1 for Raceway Identification Code and Location Illustration Code details/clarification.
Refer to Section 11-1, para 11-1.14.4 for complete LRV2 (Vehicles # 1400 through 1476) Raceway and Wiring Identification Tables (RWI) where Vehicle Section/Area lists the wiring data and the relationship with the Equipment, and with the relevant IWD Sheet #, Page # and (on IWD) Subassembly Co-ordinates.



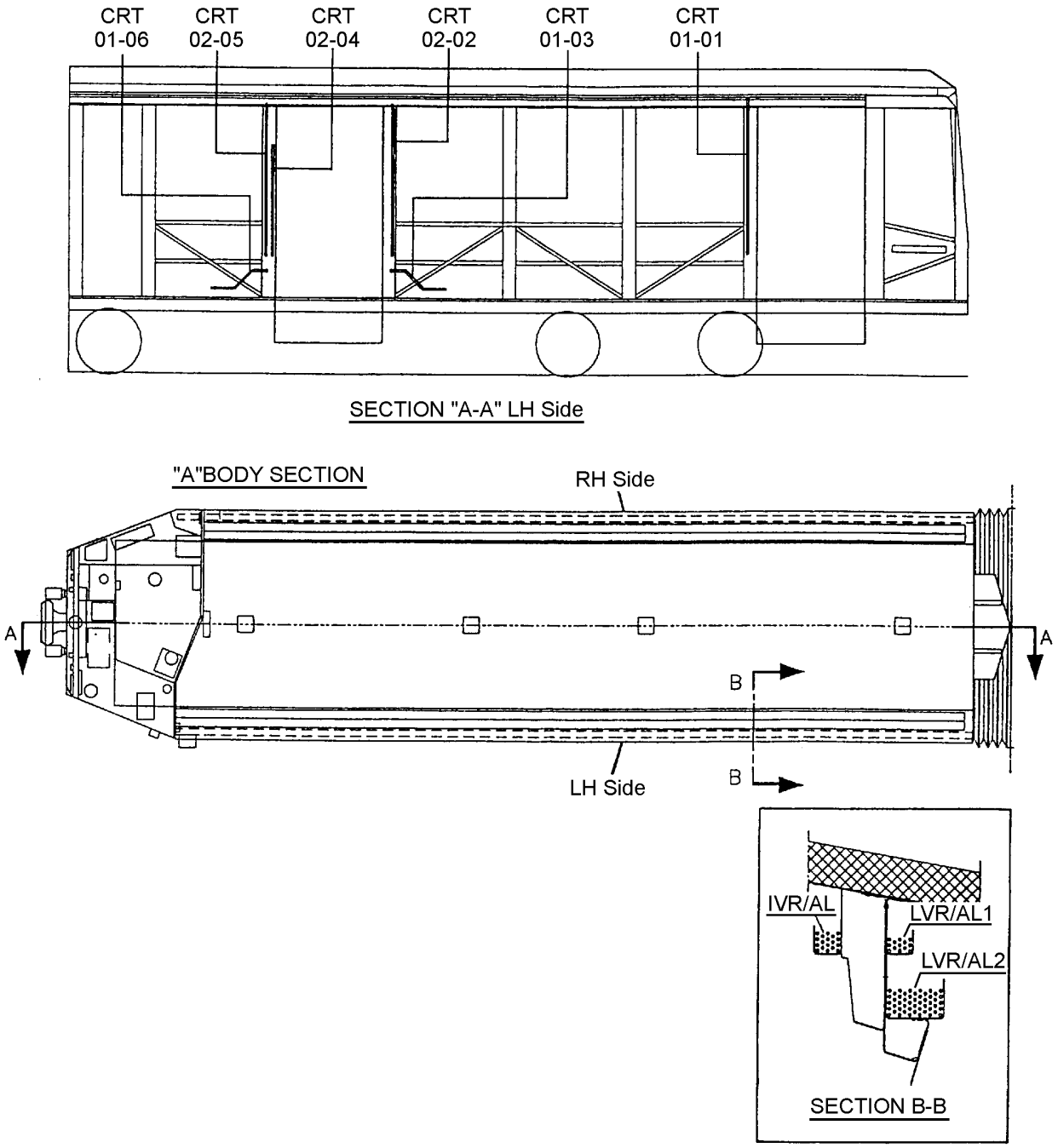
Location Illustration Code : 2-1

Figure 11-3.1 COMMUNICATIONS SYSTEM- Raceway Location – Roof



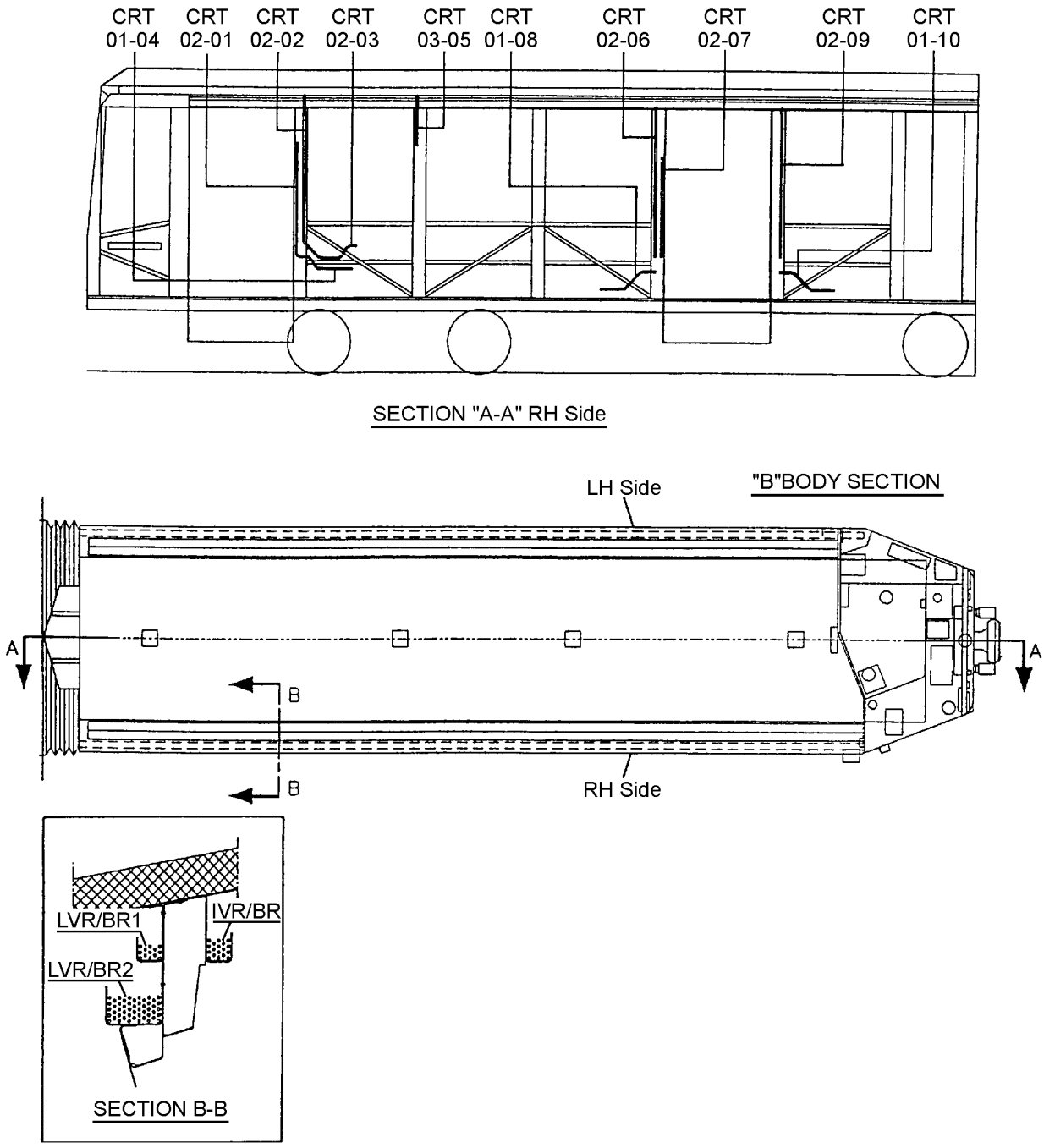
Location Illustration Code : 2-2

Figure 11-3.2 COMMUNICATIONS SYSTEM - Raceway Location
"A" Body Section RH Side



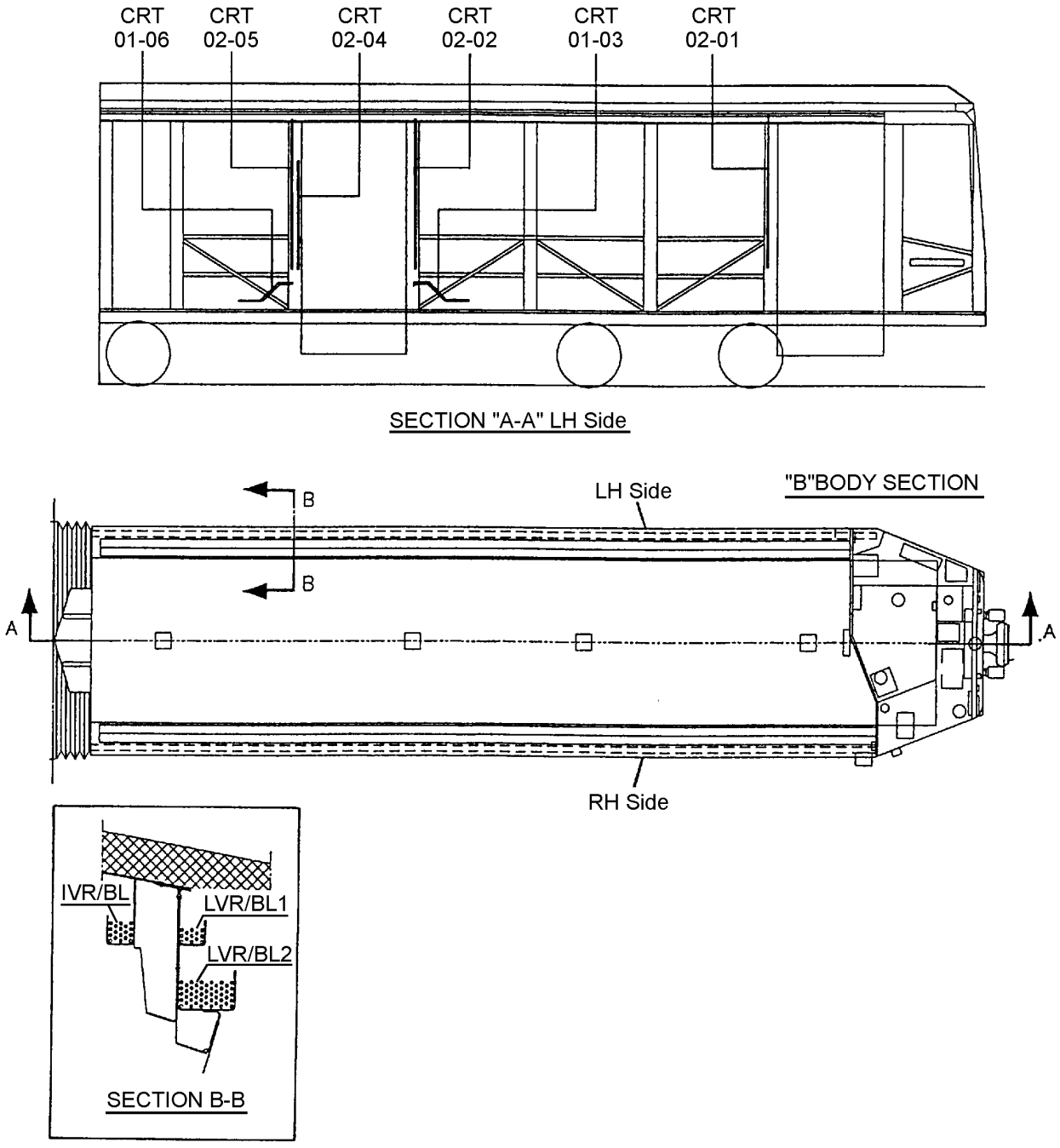
Location Illustration Code : 2-3

Figure 11-3.3 COMMUNICATIONS SYSTEM - Raceway Location - "A" Body Section - LH Side



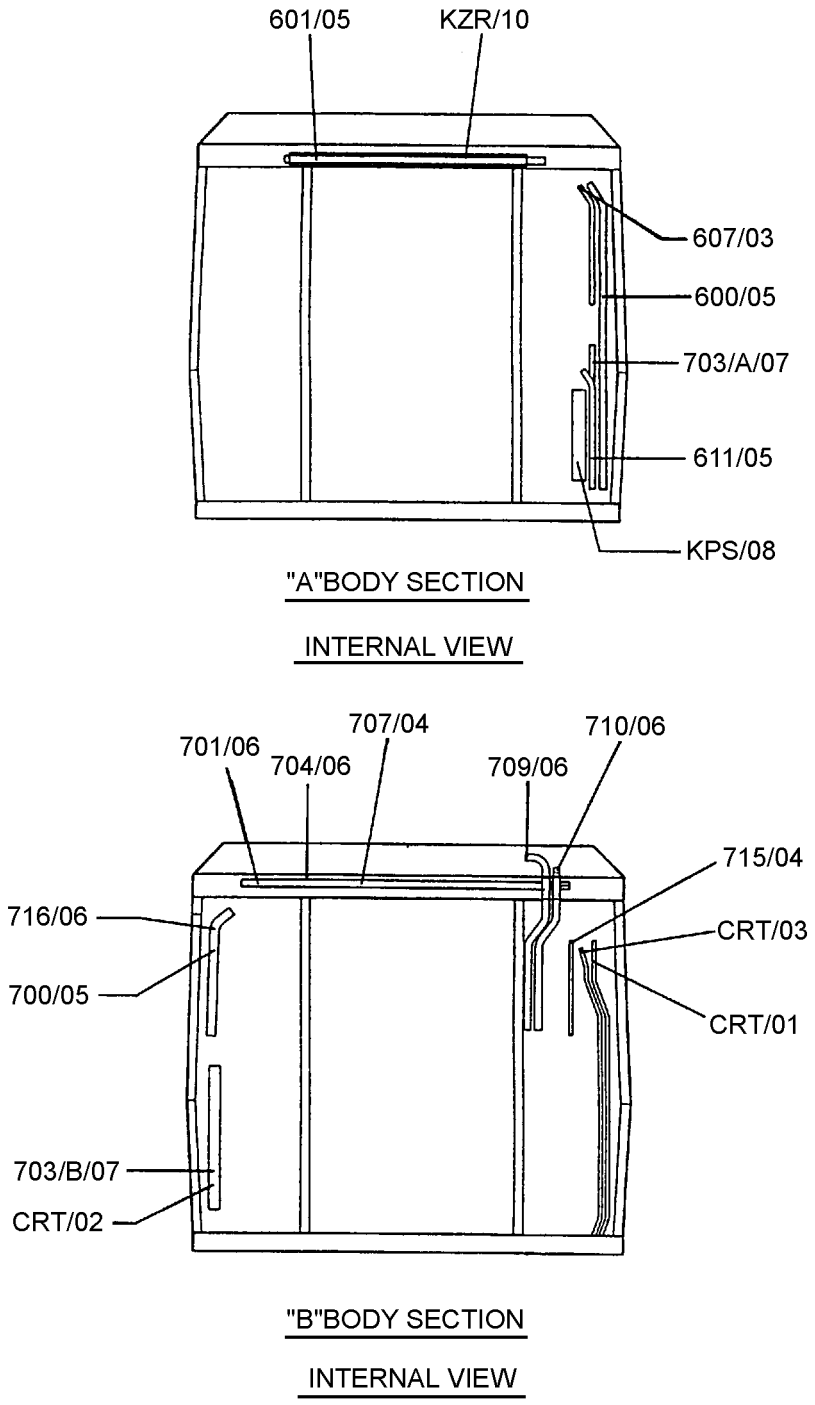
Location Illustration Code : 2-4

Figure 11-3.4 COMMUNICATIONS SYSTEM - Raceway Location
"B" Body Section RH Side



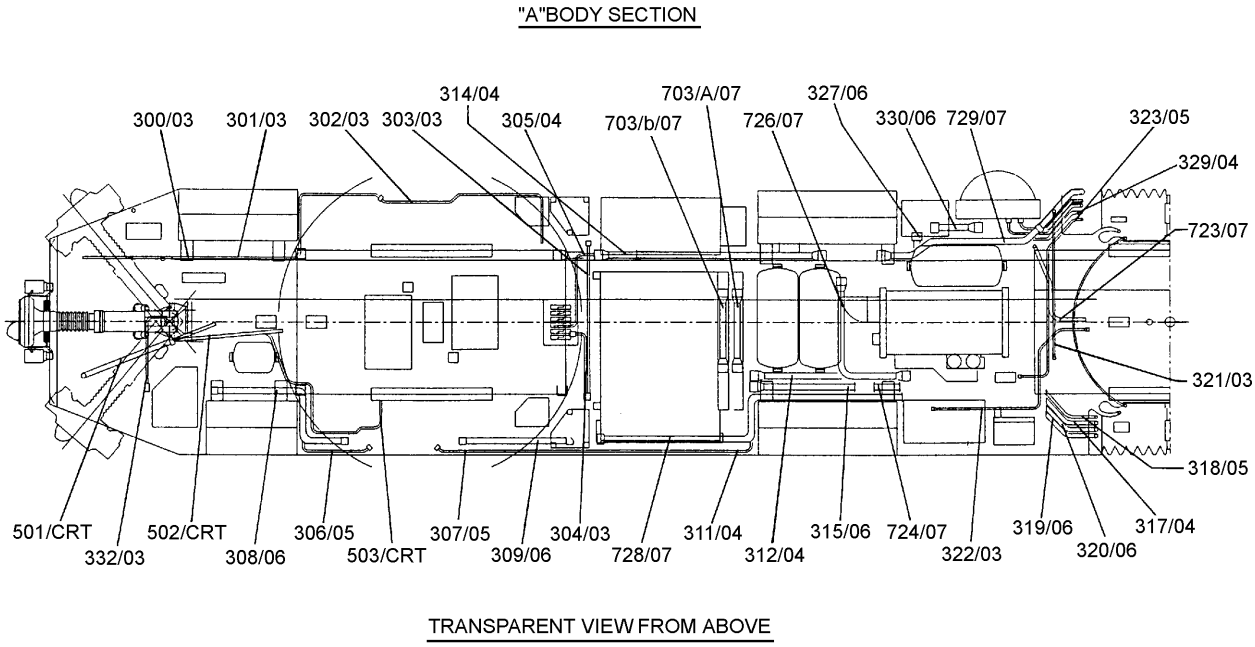
Location Illustration Code : 2-5

Figure 11-3.5 COMMUNICATIONS SYSTEM - Raceway Location - "B" Body Section - LH Side



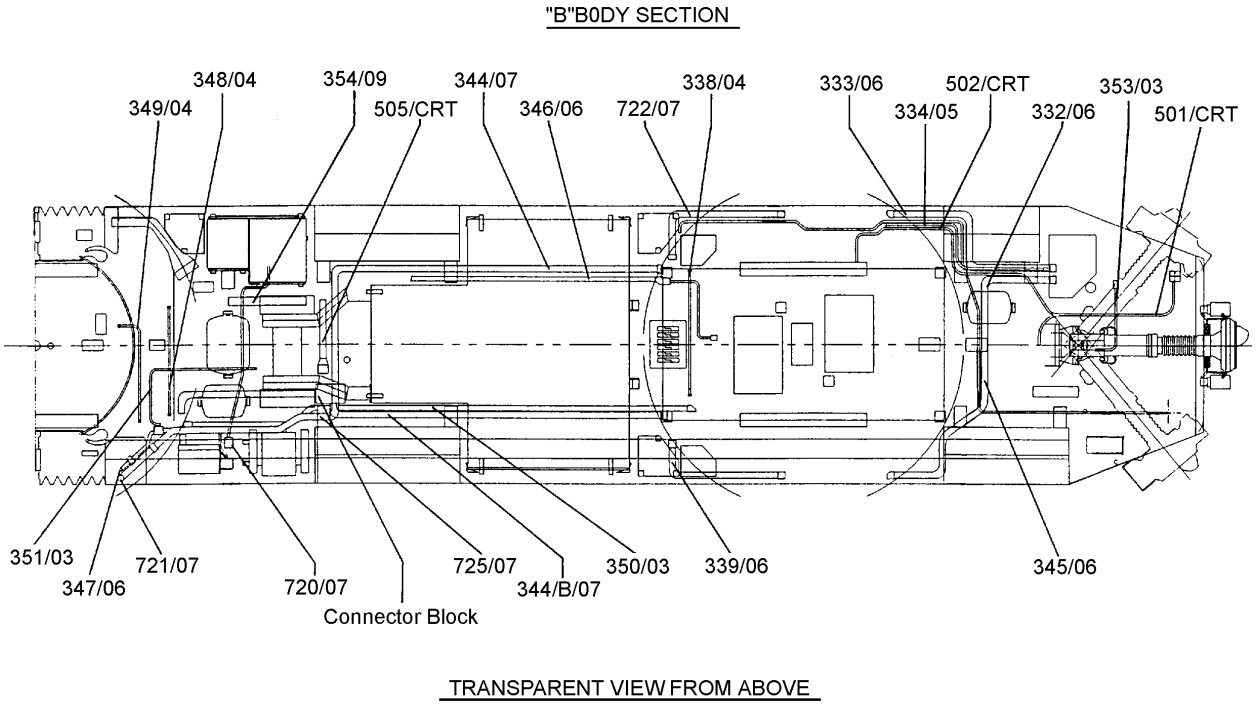
Location Illustration Code : 2-6

Figure 11-3.6 COMMUNICATIONS SYSTEM - Raceway Location
"A" and "B" Body Sections – Art. Sect. Front



Location Illustration Code : 2-7

Figure 11-3.7 COMMUNICATIONS SYSTEM - Raceway Location
“A” Body Section - Underframe



Location Illustration Code : 2-8

Figure 11-3.8 COMMUNICATIONS SYSTEM - Raceway Location
"B" Body Section - Underframe

11-3.5.2 COMMUNICATIONS SYSTEM Integrated Wiring Tables

The following pages make up the LRV2's COMMUNICATIONS SYSTEM Integrated Wiring Tables.

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RADIO ANTENNA

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: RADIO ANTENNA	E.I.C.: CA1 (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CA1 (A)	/	/	CF (A)	J3	/	♦	/	COAX. ANT.	RG58-1	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: RADIO ANTENNA	E.I.C.: CA2 (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CA2 (A)	/	/	CR (A)	/	/	♦	/	COAX. ANT.	RG58-2	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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COMMUNICATION AMPLIFIER CONTROL UNIT

CB

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT E.I.C.: CB (A)	REV: 00 PAGE: 1 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	/	/	PA (A)	P1	B4	KZR/10 LVR/A	2-6 2-1	2X16AWG	TH-142	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	1	KR (A)	TB2	18	♦	/	16AWG	35KA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	2	CW (A)	TB2	20	♦	/	16AWG	35KB-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	3	CW (A)	TB3	18	♦	/	16AWG/TH28	ET085-3	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	4	CW (A)	TB3	19	♦	/	16AWG/TH28	ET084-3	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	5	KH (A)	TB3	10	♦	/	16AWG/TH25	ET083-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	6	KH (A)	TB3	9	♦	/	16AWG/TH25	ET082-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	7	KH (A)	TB3	7	♦	/	16AWG/TH26	ET086-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	8	KH (A)	TB3	6	♦	/	16AWG/TH26	ET081-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	9	PA (A)	P1	B2	KZR/10 LVR/A	2-6 2-1	16AWG	35NA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	10	CP (A)	IN	-	♦	/	16AWG	NB43-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	11	CW (A)	TB3	17	♦	/	16AWG	36RA-3	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	12	CW (A)	TB3	16	♦	/	16AWG	36QA-3	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	13	KH (A)	TB3	8	♦	/	2X16AWG	TH-26	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT	E.I.C.: CB (A)	REV: 00 PAGE: 2 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	J2	14	CW (A)	TB3	20	♦	/	2X16AWG	TH-28	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	15	KH (A)	TB3	11	♦	/	2X16AWG	TH-25	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	16	CP (A)	IN	+	♦	/	16AWG	S43-3	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	17	CH (A)	TB	2	♦	/	16AWG/TH01	35AA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	18	CH (A)	TB	1	♦	/	16AWG/TH01	35BA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	19	CL1 (A)	TB	2	♦	/	16AWG/TH04	35CA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	20	CL1 (A)	TB	1	♦	/	16AWG/TH04	35DA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	21	CW (A)	TB1	7	♦	/	16AWG/TH18	36CA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	22	CW (A)	TB1	6	♦	/	16AWG/TH18	36DA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	23	CW (A)	TB1	8	♦	/	2X16AWG	TH-18	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	23	CL1 (A)	TB	3	♦	/	2X16AWG	TH-04	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	23	CH (A)	TB	3	♦	/	2X16AWG	TH-01	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	24	CW (A)	TB3	11	♦	/	16AWG	35EA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	25	CW (A)	TB3	10	♦	/	16AWG	35FA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT E.I.C.: CB (A)	REV: 00 PAGE: 3 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	J2	26	CW (A)	TB1	18	♦	/	16AWG	35GA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	27	EYP (A)	P10	41	605[6]/09	2-1	16AWG	35HA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	28	CP (A)	OUT	+	♦	/	16AWG	36AA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	29	CP (A)	OUT	-	♦	/	16AWG	NB43-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	30	CW (A)	TB3	8	♦	/	16AWG	36BA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	31	CW (A)	TB1	10	♦	/	16AWG/TH16	36FA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	32	CW (A)	TB1	9	♦	/	16AWG/TH16	36EA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	33	CW (A)	TB1	8	♦	/	2X16AWG	TH-16	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	34	CW (A)	TB1	12	♦	/	16AWG	36NA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	35	PA (A)	P1	B3	KZR/10 LVR/A	2-6 2-1	16AW/TH142	35LA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J2	36	PA (A)	P1	A4	KZR/10 LVR/A	2-6 2-1	16AW/TH142	35MA-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	1	CM (A)	P1	1	♦	/	16AWG	34WA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	3	CM (A)	P1	3	♦	/	16AWG	34BA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	4	CM (A)	P1	4	♦	/	16AWG	34HA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT E.I.C.: CB (A)	REV: 00	PAGE: 4 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	J3	5	CM (A)	P1	5	♦	/	16AWG	34AA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	6	CM (A)	P1	6	♦	/	16AWG	34NA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	7	CM (A)	P1	7	♦	/	16AWG	34JA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	8	CM (A)	P1	8	♦	/	16AWG	34FA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	9	CM (A)	P1	9	♦	/	16AWG	34DA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	10	CM (A)	P1	10	♦	/	16AWG	34GA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	14	CM (A)	P1	14	♦	/	16AWG	34CA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	15	CM (A)	P1	15	♦	/	2X16AWG	TH-19	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	16	CM (A)	P1	16	♦	/	16AWG	34EA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	22	CM (A)	P1	22	♦	/	16AWG	34MA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	23	CM (A)	P1	23	♦	/	16AWG	34PA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	28	CM (A)	P1	28	♦	/	16AWG	34KA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	29	CM (A)	P1	29	♦	/	16AWG/TH19	34QA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	30	CM (A)	P1	30	♦	/	16AWG/TH19	34RA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT	E.I.C.: CB (A)	REV: 00	PAGE: 5 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	J3	33	CM (A)	P1	33	♦	/	16AWG	34LA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	36	CM (A)	P1	36	♦	/	16AWG	34TA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J3	37	CM (A)	P1	37	♦	/	16AWG	34SA-1	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	1	EYP (A)	P10	27	605[6]/09	2-1	16AWG	34WB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	3	EYP (A)	P10	7	605[6]/09	2-1	16AWG	34BB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	4	EYP (A)	P10	13	605[6]/09	2-1	16AWG	34HB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	5	EYP (A)	P10	6	605[6]/09	2-1	16AWG	34AB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	6	EYP (A)	P10	20	605[6]/09	2-1	16AWG	34NB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	7	EYP (A)	P10	14	605[6]/09	2-1	16AWG	34JB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	8	EYP (A)	P10	11	605[6]/09	2-1	16AWG	34FB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	9	EYP (A)	P10	9	605[6]/09	2-1	16AWG	34DB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	10	EYP (A)	P10	12	605[6]/09	2-1	16AWG	34GB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	11	KQ (A)	TB4	16	♦	/	16AWG	36RB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	14	EYP (A)	P10	8	605[6]/09	2-1	16AWG	34CB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: COMMUNICATION AMPLIFIER CONTROL UNIT E.I.C.: CB (A)	REV: 00 PAGE: 6 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CB (A)	J4	15	EYP (A)	P10	24	605[6]/09	2-1	2X16AWG	TH-30	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	16	EYP (A)	P10	10	605[6]/09	2-1	16AWG	34EB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	22	EYP (A)	P10	19	605[6]/09	2-1	16AWG	34MB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	23	EYP (A)	P10	21	605[6]/09	2-1	16AWG	34PB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	28	EYP (A)	P10	17	605[6]/09	2-1	16AWG	34KB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	29	EYP (A)	P10	22	605[6]/09	2-1	16AWG/TH30	34QB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	30	EYP (A)	P10	23	605[6]/09	2-1	16AWG/TH30	34RB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	33	EYP (A)	P10	18	605[6]/09	2-1	16AWG	34LB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	34	CW (A)	TB2	13	♦	/	16AWG	34YD-4	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	35	CW (A)	TB2	12	♦	/	16AWG	34YC-6	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	36	EYP (A)	P10	26	605[6]/09	2-1	16AWG	34TB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CB (A)	J4	37	EYP (A)	P10	25	605[6]/09	2-1	16AWG	34SB-2	31A	11-3.35	(CDE)5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

RADIO SILENT ALARM SWITCH

CD

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: RADIO SILENT ALARM SWITCH E.I.C.: CD (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CD (A)	/	1	CW (A)	TB3	12	♦	/	16AWG	35FB-1	31A	11-3.35	A7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CD (A)	/	2	CW (A)	TB3	10	♦	/	16AWG	35FA-5	31A	11-3.35	A7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION SYSTEM CODE: 11	EQUIPMENT: RADIO SILENT ALARM SWITCH E.I.C.: CD (B)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CD (B)	/	1	CW (B)	TB3	12	♦	/	16AWG	35HB-1	31A	11-3.35	C3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CD (B)	/	2	CW (B)	TB3	10	♦	/	16AWG	35HA-4	31A	11-3.35	C3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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SIGNPOST RECEIVER

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATIONS	SYSTEM CODE: 11 EQUIPMENT: SIGNPOST RECEIVER E.I.C.: CF (A)	REV: 00 PAGE: 1 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CF (A)	/	/	PSA-1 (A)	/	G	501/CRT 502/CRT	2-7 2-7	18AW/TH144	36WA-1	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	/	/	PSA-1 (A)	/	F	501/CRT 502/CRT	2-7 2-7	18AW/TH144	36UA-1	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	J3	/	CA1 (A)	/	/	♦	/	COAX. ANT.	RG58-1	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P2	+	CW (A)	TB1	1	♦	/	(*)	RED	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P2	-	CW (A)	TB1	3	♦	/	(*)	BLK	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	BNC	/	PSA-1 (A)	/	E	501/CRT 502/CRT	2-7 2-7	18AW/TH144	36TA-1	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	BNC	/	PSA-1 (A)	/	D	501/CRT 502/CRT	2-7 2-7	18AW/TH144	36SA-1	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	BNC	/	PSA-1 (A)	/	H	501/CRT 502/CRT	2-7 2-7	4X18AWG	TH-144	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	2	♦	/	(*)	BRN-GRN	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	9	♦	/	(*)	GRY	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	3	♦	/	(*)	BRN-ORG	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	10	♦	/	(*)	BRN-BLK	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	1	♦	/	(*)	BRN-YEL	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	11	♦	/	(*)	VIO SHIELD	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATIONS	SYSTEM CODE: 11 EQUIPMENT: SIGNPOST RECEIVER E.I.C.: CF (A)	REV: 00 PAGE: 2 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CF (A)	P205	/	SM (A)	SM1-J1	8	♦	/	(*)	WHT-BLU	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	6	♦	/	(*)	WHT-GRN	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	7	♦	/	(*)	WHT-VIO	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	5	♦	/	(*)	YEL-BLU	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CF (A)	P205	/	SM (A)	SM1-J1	4	♦	/	(*)	YEL-ORG	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

SPEAKER EXTERIOR

CH

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: SPEAKER EXTERIOR	E.I.C.: CH (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CH (A)	/	1	CH (A)	TB	1	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	16AWG/TH02	35BA-3	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	/	2	CH (A)	TB	2	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	16AWG/TH02	35AA-3	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	/	/	CH (A)	TB	3	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	2X16AWG	TH-02	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	1	CB (A)	J2	18	♦	/	16AWG/TH01	35BA-1	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	1	CH (A)	/	1	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	16AWG/TH02	35BA-3	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	1	EYP (A)	P10	47	KZR/10 LVR/AR1	2-6 2-2	16AWG/TH03	35BA-2	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	2	CH (A)	/	2	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	16AWG/TH02	35AA-3	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	2	EYP (A)	P10	48	KZR/10 LVR/AR1	2-6 2-2	16AWG/TH03	35AA-2	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	2	CB (A)	J2	17	♦	/	16AWG/TH01	35AA-1	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	3	CB (A)	J2	23	♦	/	2X16AWG	TH-01	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	3	CH (A)	/	/	LVR/AR2 CRT/02-01 CRT/02-03	2-2 2-2 2-2	2X16AWG	TH-02	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (A)	TB	3	EYP (A)	P10	46	KZR/10 LVR/AR1	2-6 2-2	2X16AWG	TH-03	31A	11-3.35	A6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: SPEAKER EXTERIOR	E.I.C.: CH (B)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CH (B)	/	1	EYJ (B)	J10	47	701/06 LVR/BR1 CRT/02-02 CRT/02-03	2-6 2-4 2-4 2-4	16AWG/TH47	35BA-4	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (B)	/	2	EYJ (B)	J10	48	701/06 LVR/BR1 CRT/02-02 CRT/02-03	2-6 2-4 2-4 2-4	16AWG/TH47	35AA-4	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CH (B)	/	/	EYJ (B)	J10	46	701/06 LVR/BR1 CRT/02-02 CRT/02-03	2-6 2-4 2-4 2-4	2X16AWG	TH-47	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: INTERCOMMUNICATION UNIT PASSENGER AREA E.I.C.: CI (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CI (A)	TB	1	CW (A)	TB3	17	CRT/02-02	2-2	16AWG	36RA-1	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (A)	TB	2	CW (A)	TB3	16	CRT/02-02	2-2	16AWG	36QA-1	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (A)	TB	3	CW (A)	TB3	18	CRT/02-02	2-2	16AWG/TH29	ET085-2	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (A)	TB	4	CW (A)	TB3	19	CRT/02-02	2-2	16AWG/TH29	ET084-2	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (A)	TB	5	CW (A)	TB3	20	CRT/02-02	2-2	2X16AWG	TH-29	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: INTERCOMMUNICATION UNIT PASSENGER AREA E.I.C.: CI (B)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CI (B)	TB	1	EYJ (B)	J10	2	701/06 LVR/BR1 CRT/02-01	2-6 2-4 2-4	16AWG	36RA-4	31A	11-3.35	G2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (B)	TB	2	EYJ (B)	J10	1	701/06 LVR/BR1 CRT/02-01	2-6 2-4 2-4	16AWG	36QA-4	31A	11-3.35	G2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (B)	TB	3	KH (B)	TB3	4	LVR/BR1 CRT/02-01	2-4 2-4	16AWG/TH27	ET085-1	31A	11-3.35	G2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (B)	TB	4	KH (B)	TB3	3	LVR/BR1 CRT/02-01	2-4 2-4	16AWG/TH27	ET084-1	31A	11-3.35	G2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CI (B)	TB	5	KH (B)	TB3	5	LVR/BR1 CRT/02-01	2-4 2-4	2X16AWG	TH-27	31A	11-3.35	G2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: MOBILE DATA TERMINAL E.I.C.: CK (A)	REV: 00 PAGE: 1 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (A)	J3	1	CW (A)	TB1	5	♦	/	16AWG	35JA-1	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	J3	2	CW (A)	TB1	4	♦	/	16AWG	35JB-1	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P1	/	CW (A)	TB3	1	♦	/	(*)	WHT-BLK/SH	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P1	1	CW (A)	TB3	11	♦	/	(*)	WHT	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P1	2	CW (A)	TB3	10	♦	/	(*)	BLK	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P201	11	CW (A)	TB3	12	♦	/	(*)	ORG	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	1	♦	/	(*)	BRN-YEL	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	4	♦	/	(*)	YEL-ORG	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	5	♦	/	(*)	YEL-BLU	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	7	♦	/	(*)	WHT-VIO	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	2	♦	/	(*)	BRN-GRN	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	6	♦	/	(*)	WHT-GRN	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	10	♦	/	(*)	BRN-BLK	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	3	♦	/	(*)	BRN-ORG	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: MOBILE DATA TERMINAL E.I.C.: CK (A)	REV: 00 PAGE: 2 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (A)	P202	/	SM (A)	SM1-P1	8	♦	/	(*)	WHT-BLU	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	9	♦	/	(*)	GRY	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P202	/	SM (A)	SM1-P1	11	♦	/	(*)	VIO SHIELD	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	1	SM (A)	SM2-P1	11	♦	/	(*)	BLU	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	3	SM (A)	SM2-P1	14	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	4	SM (A)	SM2-P1	1	♦	/	(*)	VIO	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	5	SM (A)	SM2-P1	2	♦	/	(*)	GRY	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	7	SM (A)	SM2-P1	7	♦	/	(*)	BLK-VIO	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	8	SM (A)	SM2-P1	6	♦	/	(*)	BLK-BLU	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	9	SM (A)	SM2-P1	5	♦	/	(*)	BLK-ORG	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	10	SM (A)	SM2-P1	4	♦	/	(*)	BLK	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	11	SM (A)	SM2-P1	3	♦	/	(*)	WHT	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	12	SM (A)	SM2-P1	10	♦	/	(*)	BLK-BRN	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	14	SM (A)	SM2-P1	15	♦	/	(*)	RED-GRN	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: MOBILE DATA TERMINAL	E.I.C.: CK (A)	REV: 00	PAGE: 3 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (A)	P203	15	SM (A)	SM2-P1	9	♦	/	(*)	BRN	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	16	SM (A)	SM2-P1	13	♦	/	(*)	BRN/SH	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (A)	P203	19	SM (A)	SM2-P1	8	♦	/	(*)	BLK-RED	31A	11-3.35	(AB)8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: MOBILE DATA TERMINAL E.I.C.: CK (B)	REV: 00 PAGE: 1 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (B)	P1	/	CW (B)	TB3	11	♦	/	(*)	WHT-BLK/SH	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P1	1	CW (B)	TB3	9	♦	/	(*)	WHT	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P1	2	CW (B)	TB3	10	♦	/	(*)	BLK	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P201	11	CW (B)	TB3	12	♦	/	(*)	ORG	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	5	♦	/	(*)	YEL-BLU	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	4	♦	/	(*)	YEL-ORG	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	7	♦	/	(*)	WHT-VIO	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	8	♦	/	(*)	WHT-BLU	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	10	♦	/	(*)	BRN-BLK	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	6	♦	/	(*)	WHT-GRN	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	9	♦	/	(*)	GRY	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	2	♦	/	(*)	BRN-GRN	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	3	♦	/	(*)	BRN-ORG	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P202	/	KR (B)	TB6	1	♦	/	(*)	BRN-YEL	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: MOBILE DATA TERMINAL	E.I.C.: CK (B)	REV: 00	PAGE: 2 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (B)	P202	/	KR (B)	TB6	11	♦	/	(*)	VIO SHIELD	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	1	CW (B)	TB3	1	♦	/	(*)	BLU	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	3	CW (B)	TB3	15	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	4	CW (B)	TB3	2	♦	/	(*)	VIO	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	5	CW (B)	TB3	3	♦	/	(*)	GRY	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	7	CW (B)	TB3	20	♦	/	(*)	BLK-VIO	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	8	CW (B)	TB3	16	♦	/	(*)	BLK-BLU	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	9	CW (B)	TB3	17	♦	/	(*)	BLK-ORG	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	10	CW (B)	TB3	5	♦	/	(*)	BLK	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	11	CW (B)	TB3	4	♦	/	(*)	WHT	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	12	CW (B)	TB3	8	♦	/	(*)	BLK-BRN	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	14	CW (B)	TB3	10	♦	/	(*)	RED-GRN	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	15	CW (B)	TB3	7	♦	/	(*)	BRN	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CK (B)	P203	16	CW (B)	TB3	13	♦	/	(*)	BRN/SH	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: MOBILE DATA TERMINAL	E.I.C.: CK (B)	REV: 00	PAGE: 3 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CK (B)	P203	19	CW (B)	TB3	6	♦	/	(*)	BLK-RED	31A	11-3.35	(BC)2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: INTERIOR SPEAKERS	E.I.C.: CL1 (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL1 (A)	/	1	CL1 (A)	TB	1	♦	/	16AWG/TH05	35DA-2	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	/	2	CL1 (A)	TB	2	♦	/	16AWG/TH05	35CA-2	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	/	/	CL1 (A)	TB	3	♦	/	2X16AWG	TH-05	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	1	CL1 (A)	/	1	♦	/	16AWG/TH05	35DA-2	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	1	CB (A)	J2	20	♦	/	16AWG/TH04	35DA-1	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	1	CL2 (A)	TB	1	LVR/AL2	2-3	16AWG/TH06	35DA-3	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	2	CL1 (A)	/	2	♦	/	16AWG/TH05	35CA-2	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	2	CL2 (A)	TB	2	LVR/AL2	2-3	16AWG/TH06	35CA-3	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	2	CB (A)	J2	19	♦	/	16AWG/TH04	35CA-1	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	3	CB (A)	J2	23	♦	/	2X16AWG	TH-04	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	3	CL1 (A)	/	/	♦	/	2X16AWG	TH-05	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (A)	TB	3	CL2 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-06	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: INTERIOR SPEAKERS	E.I.C.: CL1 (B)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL1 (B)	/	1	CL2 (B)	TB	1	LVR/BL1	2-5	16AWG/TH45	35DA-16	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (B)	/	2	CL2 (B)	TB	2	LVR/BL1	2-5	16AWG/TH45	35CA-16	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL1 (B)	/	/	CL2 (B)	TB	3	LVR/BL1	2-5	2X16AWG	TH-45	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: INTERIOR SPEAKERS	E.I.C.: CL2 (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL2 (A)	/	1	CL2 (A)	TB	1	♦	/	16AWG/TH07	35DA-4	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	/	2	CL2 (A)	TB	2	♦	/	16AWG/TH07	35CA-4	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	/	/	CL2 (A)	TB	3	♦	/	2X16AWG	TH-07	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	1	CL2 (A)	/	1	♦	/	16AWG/TH07	35DA-4	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	1	CL1 (A)	TB	1	LVR/AL2	2-3	16AWG/TH06	35DA-3	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	1	CL3 (A)	TB	1	LVR/AL2	2-3	16AWG/TH08	35DA-5	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	2	CL2 (A)	/	2	♦	/	16AWG/TH07	35CA-4	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	2	CL3 (A)	TB	2	LVR/AL2	2-3	16AWG/TH08	35CA-5	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	2	CL1 (A)	TB	2	LVR/AL2	2-3	16AWG/TH06	35CA-3	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	3	CL1 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-06	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	3	CL2 (A)	/	/	♦	/	2X16AWG	TH-07	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (A)	TB	3	CL3 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-08	31A	11-3.35	A5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: INTERIOR SPEAKER	E.I.C.: CL2 (B)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL2 (B)	/	1	CL2 (B)	TB	1	♦	/	16AWG/TH46	35DA-15	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	/	2	CL2 (B)	TB	2	♦	/	16AWG/TH46	35CA-15	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	/	/	CL2 (B)	TB	3	♦	/	2X16AWG	TH-46	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	1	CL2 (B)	/	1	♦	/	16AWG/TH46	35DA-15	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	1	CL3 (B)	TB	1	LVR/BL1	2-5	16AWG/TH43	35DA-14	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	1	CL1 (B)	/	1	LVR/BL1	2-5	16AWG/TH45	35DA-16	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	2	CL1 (B)	/	2	LVR/BL1	2-5	16AWG/TH45	35CA-16	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	2	CL2 (B)	/	2	♦	/	16AWG/TH46	35CA-15	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	2	CL3 (B)	TB	2	LVR/BL1	2-5	16AWG/TH43	35CA-14	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	3	CL3 (B)	TB	3	LVR/BL1	2-5	2X16AWG	TH-43	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	3	CL1 (B)	/	/	LVR/BL1	2-5	2X16AWG	TH-45	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL2 (B)	TB	3	CL2 (B)	/	/	♦	/	2X16AWG	TH-46	31A	11-3.35	A2	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: INTERIOR SPEAKERS E.I.C.: CL3 (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL3 (A)	/	1	CL3 (A)	TB	1	♦	/	16AWG/TH09	35DA-6	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	/	2	CL3 (A)	TB	2	♦	/	16AWG/TH09	35CA-6	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	/	/	CL3 (A)	TB	3	♦	/	2X16AWG	TH-09	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	1	CL3 (A)	/	1	♦	/	16AWG/TH09	35DA-6	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	1	CL2 (A)	TB	1	LVR/AL2	2-3	16AWG/TH08	35DA-5	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	1	CL4 (A)	TB	1	LVR/AL2	2-3	16AWG/TH10	35DA-7	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	2	CL3 (A)	/	2	♦	/	16AWG/TH09	35CA-6	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	2	CL4 (A)	TB	2	LVR/AL2	2-3	16AWG/TH10	35CA-7	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	2	CL2 (A)	TB	2	LVR/AL2	2-3	16AWG/TH08	35CA-5	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	3	CL2 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-08	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	3	CL3 (A)	/	/	♦	/	2X16AWG	TH-09	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (A)	TB	3	CL4 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-10	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: EXTERIOR SPEAKERS E.I.C.: CL3 (B)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL3 (B)	/	1	CL3 (B)	TB	1	♦	/	16AWG/TH44	35DA-13	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	/	2	CL3 (B)	TB	2	♦	/	16AWG/TH44	35CA-13	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	/	/	CL3 (B)	TB	3	♦	/	2X16AWG	TH-44	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	1	CL3 (B)	/	1	♦	/	16AWG/TH44	35DA-13	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	1	CL4 (B)	TB	1	LVR/BL1	2-5	16AWG/TH41	35DA-12	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	1	CL2 (B)	TB	1	LVR/BL1	2-5	16AWG/TH43	35DA-14	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	2	CL2 (B)	TB	2	LVR/BL1	2-5	16AWG/TH43	35CA-14	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	2	CL3 (B)	/	2	♦	/	16AWG/TH44	35CA-13	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	2	CL4 (B)	TB	2	LVR/BL1	2-5	16AWG/TH41	35CA-12	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	3	CL4 (B)	TB	3	LVR/BL1	2-5	2X16AWG	TH-41	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	3	CL2 (B)	TB	3	LVR/BL1	2-5	2X16AWG	TH-43	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL3 (B)	TB	3	CL3 (B)	/	/	♦	/	2X16AWG	TH-44	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: EXTERIOR SPEAKER E.I.C.: CL4 (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL4 (A)	/	1	CL4 (A)	TB	1	♦	/	16AWG/TH11	35DA-8	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	/	2	CL4 (A)	TB	2	♦	/	16AWG/TH11	35CA-8	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	/	/	CL4 (A)	TB	3	♦	/	2X16AWG	TH-11	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	1	CL4 (A)	/	1	♦	/	16AWG/TH11	35DA-8	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	1	CL3 (A)	TB	1	LVR/AL2	2-3	16AWG/TH10	35DA-7	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	1	EYP (A)	P10	43	LVR/AL2	2-3	16AWG/TH12	35DA-9	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	2	CL4 (A)	/	2	♦	/	16AWG/TH11	35CA-8	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	2	EYP (A)	P10	44	LVR/AL2	2-3	16AWG/TH12	35CA-9	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	2	CL3 (A)	TB	2	LVR/AL2	2-3	16AWG/TH10	35CA-7	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	3	CL3 (A)	TB	3	LVR/AL2	2-3	2X16AWG	TH-10	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	3	CL4 (A)	/	/	♦	/	2X16AWG	TH-11	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (A)	TB	3	EYP (A)	P10	45	LVR/AL2	2-3	2X16AWG	TH-12	31A	11-3.35	A4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: EXTERIOR SPEAKERS	E.I.C.: CL4 (B)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CL4 (B)	/	1	CL4 (B)	TB	1	♦	/	16AWG/TH42	35DA-11	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	/	2	CL4 (B)	TB	2	♦	/	16AWG/TH42	35CA-11	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	/	/	CL4 (B)	TB	3	♦	/	2X16AWG	TH-42	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	1	CL4 (B)	/	1	♦	/	16AWG/TH42	35DA-11	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	1	EYJ (B)	J10	43	605[6]/09 LVR/BL1	2-1 2-5	16AWG/TH40	35DA-10	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	1	CL3 (B)	TB	1	LVR/BL1	2-5	16AWG/TH41	35DA-12	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	2	CL3 (B)	TB	2	LVR/BL1	2-5	16AWG/TH41	35CA-12	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	2	CL4 (B)	/	2	♦	/	16AWG/TH42	35CA-11	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	2	EYJ (B)	J10	44	605[6]/09 LVR/BL1	2-1 2-5	16AWG/TH40	35CA-10	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	3	EYJ (B)	J10	45	LVR/BL1	2-5	2X16AWG	TH-40	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	3	CL3 (B)	TB	3	LVR/BL1	2-5	2X16AWG	TH-41	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CL4 (B)	TB	3	CL4 (B)	/	/	♦	/	2X16AWG	TH-42	31A	11-3.35	A3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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COMMUNICATION CONTROL UNIT

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION CONTROL UNIT	E.I.C.: CM (A)	REV: 00	PAGE: 1 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CM (A)	/	/	CW (A)	TB3	13	♦	/	2X16AWG	TH-22	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	J1	34	KB (A)	TB6	7	♦	/	16AWG	ET065-2	30	11-3.29	(BC)6	N.A.	
CM (A)	P1	1	CB (A)	J3	1	♦	/	16AWG	34WA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	3	CB (A)	J3	3	♦	/	16AWG	34BA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	4	CB (A)	J3	4	♦	/	16AWG	34HA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	5	CB (A)	J3	5	♦	/	16AWG	34AA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	6	CB (A)	J3	6	♦	/	16AWG	34NA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	7	CB (A)	J3	7	♦	/	16AWG	34JA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	8	CB (A)	J3	8	♦	/	16AWG	34FA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	9	CB (A)	J3	9	♦	/	16AWG	34DA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	10	CB (A)	J3	10	♦	/	16AWG	34GA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	14	CB (A)	J3	14	♦	/	16AWG	34CA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	15	CB (A)	J3	15	♦	/	2X16AWG	TH-19	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	16	CB (A)	J3	16	♦	/	16AWG	34EA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	22	CB (A)	J3	22	♦	/	16AWG	34MA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: COMMUNICATION CONTROL UNIT E.I.C.: CM (A)	REV: 00 PAGE: 2 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CM (A)	P1	23	CB (A)	J3	23	♦	/	16AWG	34PA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	28	CB (A)	J3	28	♦	/	16AWG	34KA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	29	CB (A)	J3	29	♦	/	16AWG/TH19	34QA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	30	CB (A)	J3	30	♦	/	16AWG/TH19	34RA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	31	CW (A)	TB3	14	♦	/	16AWG/TH22	36CA-4	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	32	CW (A)	TB3	15	♦	/	16AWG/TH22	36DA-4	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	33	CB (A)	J3	33	♦	/	16AWG	34LA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	36	CB (A)	J3	36	♦	/	16AWG	34TA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	P1	37	CB (A)	J3	37	♦	/	16AWG	34SA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	TB1	SH	PCS-1 (A)	/	3	♦	/	2x16AWG	TH-160	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	TB1	BLK	PCS-1 (A)	/	2	♦	/	16AW/TH160	33BA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (A)	TB1	RED	PCS-1 (A)	/	1	♦	/	16AW/TH160	33AA-1	31A	11-3.35	(DE)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION CONTROL UNIT	E.I.C.: CM (B)	REV: 00	PAGE: 1 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CM (B)	/	/	EYJ (B)	J10	3	605[6]/09	2-1	2X16AWG	TH-34	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	J1	34	KB (B)	TB6	7	♦	/	16AWG	ET065-2	30	11-3.29	(BC)3	N.A.	
CM (B)	P1	1	EYJ (B)	J10	27	605[6]/09	2-1	16AWG	34WB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	3	EYJ (B)	J10	7	605[6]/09	2-1	16AWG	34BB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	4	EYJ (B)	J10	13	605[6]/09	2-1	16AWG	34HB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	5	EYJ (B)	J10	6	605[6]/09	2-1	16AWG	34AB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	6	EYJ (B)	J10	20	605[6]/09	2-1	16AWG	34NB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	7	EYJ (B)	J10	14	605[6]/09	2-1	16AWG	34JB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	8	EYJ (B)	J10	11	605[6]/09	2-1	16AWG	34FB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	9	EYJ (B)	J10	9	605[6]/09	2-1	16AWG	34DB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	10	EYJ (B)	J10	12	605[6]/09	2-1	16AWG	34GB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	14	EYJ (B)	J10	8	605[6]/09	2-1	16AWG	34CB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	15	EYJ (B)	J10	24	605[6]/09	2-1	2X16AWG	TH-36	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	16	EYJ (B)	J10	10	605[6]/09	2-1	16AWG	34EB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	22	EYJ (B)	J10	19	605[6]/09	2-1	16AWG	34MB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: COMMUNICATION CONTROL UNIT	E.I.C.: CM (B)	REV: 00	PAGE: 2 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CM (B)	P1	23	EYJ (B)	J10	21	605[6]/09	2-1	16AWG	34PB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	28	EYJ (B)	J10	17	605[6]/09	2-1	16AWG	34KB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	29	EYJ (B)	J10	22	605[6]/09	2-1	16AWG/TH36	34QB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	30	EYJ (B)	J10	23	605[6]/09	2-1	16AWG/TH36	34RB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	31	EYJ (B)	J10	4	605[6]/09	2-1	16AWG/TH34	36CA-6	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	32	EYJ (B)	J10	5	605[6]/09	2-1	16AWG/TH34	36DA-6	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	33	EYJ (B)	J10	18	605[6]/09	2-1	16AWG	34LB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	36	EYJ (B)	J10	26	605[6]/09	2-1	16AWG	34TB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	P1	37	EYJ (B)	J10	25	605[6]/09	2-1	16AWG	34SB-3	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	TB1	SH	PCS-1 (B)	/	3	♦	/	2x16AWG	TH-160	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	TB1	BLK	PCS-1 (B)	/	2	♦	/	16AW/TH160	33BA-1	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CM (B)	TB1	RED	PCS-1 (B)	/	1	♦	/	16AW/TH160	33AA-1	31A	11-3.35	(DE)3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

RADIO POWER SUPPLY

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: RADIO POWER SUPPLY	E.I.C.: CP (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CP (A)	IN	+	KQ (A)	TB11	3	♦	/	16AWG	S43-4	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	IN	+	KB (A)	TB8	1	♦	/	6AWG	S43-2	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	IN	+	CB (A)	J2	16	♦	/	16AWG	S43-3	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	IN	+	KB (A)	TB8	1	♦	/	6AWG	S43-2	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	IN	-	KB (A)	NB AUX.	23	♦	/	6AWG	NB43	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	IN	-	CB (A)	J2	10	♦	/	16AWG	NB43-1	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	OUT	+	CW (A)	TB1	1	♦	/	12AWG	36AA-3	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	OUT	+	CB (A)	J2	28	♦	/	16AWG	36AA-2	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	OUT	-	CB (A)	J2	29	♦	/	16AWG	NB43-2	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CP (A)	OUT	-	CW (A)	TB1	2+3	♦	/	12AWG	NB43-3	31A	11-3.35	F8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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RADIO EQUIPMENT

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: RADIO EQUIPMENT E.I.C.: CR (A)	REV: 00 PAGE: 1 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CR (A)	/	/	CA2 (A)	/	/	♦	/	COAX. ANT.	RG58-2	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	/	/	CW (A)	TB1	11	♦	/	(*)	BLK-YEL/SH	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	/	/	CW (A)	TB1	11	♦	/	(*)	BLK-GRN/SH	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	/	/	CW (A)	TB1	11	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	2	CW (A)	TB3	8	♦	/	(*)	BLK-BRN	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	3	CW (A)	TB1	9	♦	/	(*)	BLK-YEL	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	4	CW (A)	TB3	6	♦	/	(*)	BLK-RED	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	5	CW (A)	TB1	4	♦	/	(*)	ORG	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	A	CV (A)	OUT	/	♦	/	(*)	RED	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	B	CW (A)	TB1	2	♦	/	(*)	BLK	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	12	CW (A)	TB1	13	♦	/	(*)	BLK-ORG	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	13	CW (A)	TB3	2	♦	/	(*)	VIO	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	14	CW (A)	TB3	9	♦	/	(*)	BRN/SH	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	15	CW (A)	TB1	5	♦	/	(*)	GRN	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: RADIO EQUIPMENT E.I.C.: CR (A)	REV: 00 PAGE: 2 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CR (A)	P204	16	CW (A)	TB1	14	♦	/	(*)	BLK-BLU	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	17	CW (A)	TB3	3	♦	/	(*)	GRY	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	22	CW (A)	TB1	7	♦	/	(*)	RED-BLU	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	23	CW (A)	TB1	15	♦	/	(*)	BLK-VIO	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	24	CW (A)	TB3	4	♦	/	(*)	WHT	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	25	CW (A)	TB3	5	♦	/	(*)	BLK	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	27	CW (A)	TB3	7	♦	/	(*)	BRN	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	28	CW (A)	TB1	10	♦	/	(*)	BLK-GRN	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	32	CW (A)	TB1	12	♦	/	(*)	BLU	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CR (A)	P204	37	CW (A)	TB1	6	♦	/	(*)	YEL	31A	11-3.35	C8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

POWER LINE FILTER

CV

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION SYSTEM CODE: 11	EQUIPMENT: POWER LINE FILTER E.I.C.: CV (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CV (A)	IN	/	CW (A)	TB1	3	♦	/	(*)	BLK	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CV (A)	IN	/	CW (A)	TB1	1	♦	/	(*)	RED	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CV (A)	OUT	/	CR (A)	P204	A	♦	/	(*)	RED	31A	11-3.35	D8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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TERMINAL BOARD PANEL

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 1 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB1	1	CP (A)	OUT	+	♦	/	12AWG	36AA-3	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	1	SM (A)	JA	2	♦	/	16AWG	36AA-6	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	1	CV (A)	IN	/	♦	/	(*)	RED	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	1	CF (A)	P2	+	♦	/	(*)	RED	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	2	SM (A)	JA	3	♦	/	16AWG	NB43-12	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	2	CR (A)	P204	B	♦	/	(*)	BLK	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	3	CV (A)	IN	/	♦	/	(*)	BLK	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	3	CF (A)	P2	-	♦	/	(*)	BLK	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	4	CR (A)	P204	5	♦	/	(*)	ORG	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	4	CK (A)	J3	2	♦	/	16AWG	35JB-1	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	5	CR (A)	P204	15	♦	/	(*)	GRN	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	5	CK (A)	J3	1	♦	/	16AWG	35JA-1	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	6	CR (A)	P204	37	♦	/	(*)	YEL	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	6	CW (A)	TB3	15	♦	/	16AWG/TH21	36DA-3	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 2 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB1	6	CB (A)	J2	22	♦	/	16AWG/TH18	36DA-2	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	7	CR (A)	P204	22	♦	/	(*)	RED-BLU	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	7	CB (A)	J2	21	♦	/	16AWG/TH18	36CA-2	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	7	CW (A)	TB3	14	♦	/	16AWG/TH21	36CA-3	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	8	CW (A)	TB1	11	♦	/	16AWG	TH-146	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	8	CB (A)	J2	33	♦	/	2X16AWG	TH-16	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	8	CB (A)	J2	23	♦	/	2X16AWG	TH-18	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	8	CW (A)	TB3	13	♦	/	2X16AWG	TH-21	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	9	CR (A)	P204	3	♦	/	(*)	BLK-YEL	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	9	CB (A)	J2	32	♦	/	16AWG/TH16	36EA-1	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	10	CB (A)	J2	31	♦	/	16AWG/TH16	36FA-1	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	10	CR (A)	P204	28	♦	/	(*)	BLK-GRN	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	11	CR (A)	/	/	♦	/	(*)	BLK-YEL/SH	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	11	CR (A)	/	/	♦	/	(*)	BLK-GRN/SH	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 3 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB1	11	SM (A)	SM2-J1	14	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	11	CR (A)	/	/	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	D7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	12	CB (A)	J2	34	♦	/	16AWG	36NA-2	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	12	SM (A)	SM2-J1	11	♦	/	(*)	BLU	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	12	CR (A)	P204	32	♦	/	(*)	BLU	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	13	SM (A)	SM2-J1	5	♦	/	(*)	BLK-ORG	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	13	CR (A)	P204	12	♦	/	(*)	BLK-ORG	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	14	SM (A)	SM2-J1	6	♦	/	(*)	BLK-BLU	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	14	CR (A)	P204	16	♦	/	(*)	BLK-BLU	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	15	CR (A)	P204	23	♦	/	(*)	BLK-VIO	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	15	SM (A)	SM2-J1	7	♦	/	(*)	BLK-VIO	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	16	KQ (A)	TB11	11	♦	/	16AWG	S43-6	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	17	KQ (A)	TB11	17	♦	/	16AWG	S43-5	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	18	EYP (A)	P10	40	605[6]/09	2-1	16AWG	35GA-1	31A	11-3.35	C5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 4 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB1	18	SM (A)	JA	1	♦	/	16AWG	35GA-3	31A	11-3.35	C5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	18	CB (A)	J2	26	♦	/	16AWG	35GA-2	31A	11-3.35	C5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB1	2+3	CP (A)	OUT	-	♦	/	12AWG	NB43-3	31A	11-3.35	E8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	12	CB (A)	J4	35	♦	/	16AWG	34YC-6	31A	11-3.35	E4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	12	KQ (A)	TB11	4	♦	/	16AWG	34YC-7	31A	11-3.35	E4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	13	CB (A)	J4	34	♦	/	16AWG	34YD-4	31A	11-3.35	E4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	13	KQ (A)	TB11	1	♦	/	16AWG	34YD-5	31A	11-3.35	E4	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	20	KR (A)	TB2	17	♦	/	16AWG	35KB-2	31A	11-3.35	D5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	20	CB (A)	J2	2	♦	/	16AWG	35KB-1	31A	11-3.35	D5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB2	20	AA (A)	P4	g	KZR/10	2-6	16AWG	35KB-4	31A	11-3.35	D5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	1	MX (A)	A20	/	♦	/	16AWG	G34	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	1	CK (A)	P1	/	♦	/	(*)	WHT-BLK/SH	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	2	SM (A)	SM2-J1	1	♦	/	(*)	VIO	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	2	CR (A)	P204	13	♦	/	(*)	VIO	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 5 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB3	3	SM (A)	SM2-J1	2	♦	/	(*)	GRY	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	3	CR (A)	P204	17	♦	/	(*)	GRY	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	4	CR (A)	P204	24	♦	/	(*)	WHT	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	4	SM (A)	SM2-J1	3	♦	/	(*)	WHT	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	5	CR (A)	P204	25	♦	/	(*)	BLK	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	5	SM (A)	SM2-J1	4	♦	/	(*)	BLK	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	6	CR (A)	P204	4	♦	/	(*)	BLK-RED	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	6	SM (A)	SM2-J1	8	♦	/	(*)	BLK-RED	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	7	CR (A)	P204	27	♦	/	(*)	BRN	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	7	SM (A)	SM2-J1	9	♦	/	(*)	BRN	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	8	CR (A)	P204	2	♦	/	(*)	BLK-BRN	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	8	CB (A)	J2	30	♦	/	16AWG	36BA-2	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	8	SM (A)	SM2-J1	10	♦	/	(*)	BLK-BRN	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	9	CR (A)	P204	14	♦	/	(*)	BRN/SH	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 6 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB3	9	SM (A)	SM2-J1	13	♦	/	(*)	BRN/SH	31A	11-3.35	C7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	10	CK (A)	P1	2	♦	/	(*)	BLK	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	10	CD (A)	/	2	♦	/	16AWG	35FA-5	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	10	SM (A)	SM2-P1	16	♦	/	16AWG	35FA-10	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	10	CB (A)	J2	25	♦	/	16AWG	35FA-1	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	11	CB (A)	J2	24	♦	/	16AWG	35EA-1	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	11	CK (A)	P1	1	♦	/	(*)	WHT	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	12	CK (A)	P201	11	♦	/	(*)	ORG	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	12	CD (A)	/	1	♦	/	16AWG	35FB-1	31A	11-3.35	A8	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	13	CM (A)	/	/	♦	/	2X16AWG	TH-22	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	13	EYP (A)	P10	3	605[6]/09	2-1	2X16AWG	TH-23	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	13	CW (A)	TB1	8	♦	/	2X16AWG	TH-21	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	14	CM (A)	P1	31	♦	/	16AWG/TH22	36CA-4	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	14	CW (A)	TB1	7	♦	/	16AWG/TH21	36CA-3	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (A)	REV: 00 PAGE: 7 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB3	14	EYP (A)	P10	4	605[6]/09	2-1	16AWG/TH23	36CA-5	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	15	CW (A)	TB1	6	♦	/	16AWG/TH21	36DA-3	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	15	EYP (A)	P10	5	605[6]/09	2-1	16AWG/TH23	36DA-5	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	15	CM (A)	P1	32	♦	/	16AWG/TH22	36DA-4	31A	11-3.35	E6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	16	CB (A)	J2	12	♦	/	16AWG	36QA-3	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	16	EYP (A)	P10	1	605[6]/09	2-1	16AWG	36QA-2	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	16	CI (A)	TB	2	CRT/02-02	2-2	16AWG	36QA-1	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	17	CB (A)	J2	11	♦	/	16AWG	36RA-3	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	17	CI (A)	TB	1	CRT/02-02	2-2	16AWG	36RA-1	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	17	EYP (A)	P10	2	605[6]/09	2-1	16AWG	36RA-2	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	17	KQ (A)	TB4	15	♦	/	16AWG	36RA-5	31A	11-3.35	G5	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	18	CI (A)	TB	3	CRT/02-02	2-2	16AWG/TH29	ET085-2	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	18	KH (A)	TB3	4	♦	/	16AWG/TH27	ET085-1	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	18	CB (A)	J2	3	♦	/	16AWG/TH28	ET085-3	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: TERMINAL BOARD PANEL	E.I.C.: CW (A)	REV: 00	PAGE: 8 OF 8

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (A)	TB3	19	KH (A)	TB3	3	♦	/	16AWG/TH27	ET084-1	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	19	CB (A)	J2	4	♦	/	16AWG/TH28	ET084-3	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	19	CI (A)	TB	4	CRT/02-02	2-2	16AWG/TH29	ET084-2	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	20	KH (A)	TB3	5	♦	/	2X16AWG	TH-27	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	20	CB (A)	J2	14	♦	/	2X16AWG	TH-28	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (A)	TB3	20	CI (A)	TB	5	CRT/02-02	2-2	2X16AWG	TH-29	31A	11-3.35	G7	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: TERMINAL BOARD PANEL	E.I.C.: CW (B)	REV: 00	PAGE: 1 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (B)	TB3	/	KB (B)	TB5	13	♦	/	2X16AWG	TH-152	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	1	EYJ (B)	J10	32	605[6]/09	2-1	16AWG	36NA-6	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	1	CK (B)	P203	1	♦	/	(*)	BLU	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	2	CK (B)	P203	4	♦	/	(*)	VIO	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	2	EYJ (B)	J10	33	605[6]/09	2-1	16AWG	36HA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	3	CK (B)	P203	5	♦	/	(*)	GRY	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	3	EYJ (B)	J10	34	605[6]/09	2-1	16AWG	36JA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	4	CK (B)	P203	11	♦	/	(*)	WHT	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	4	EYJ (B)	J10	35	605[6]/09	2-1	16AWG	36KA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	5	EYJ (B)	J10	36	605[6]/09	2-1	16AWG	36LA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	5	CK (B)	P203	10	♦	/	(*)	BLK	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	6	EYJ (B)	J10	37	605[6]/09	2-1	16AWG	36MA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	6	CK (B)	P203	19	♦	/	(*)	BLK-RED	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	7	CK (B)	P203	15	♦	/	(*)	BRN	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (B)	REV: 00 PAGE: 2 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (B)	TB3	7	EYJ (B)	J10	38	605[6]/09	2-1	16AWG/TH38	36GA-5	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	8	KB (B)	TB5	12	♦	/	16AW/TH152	36BA-6	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	8	CK (B)	P203	12	♦	/	(*)	BLK-BRN	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	9	CK (B)	P1	1	♦	/	(*)	WHT	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	9	EYJ (B)	J10	40	605[6]/09	2-1	16AWG	35GA-2	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	10	CK (B)	P203	14	♦	/	(*)	RED-GRN	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	10	CK (B)	P1	2	♦	/	(*)	BLK	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	10	EYJ (B)	J10	41	605[6]/09	2-1	16AWG	35HA-2	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	10	CD (B)	/	2	♦	/	16AWG	35HA-4	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	11	CK (B)	P1	/	♦	/	(*)	WHT-BLK/SH	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	11	MX (B)	B20	/	♦	/	16AWG	G34	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	12	CD (B)	/	1	♦	/	16AWG	35HB-1	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	12	CK (B)	P201	11	♦	/	(*)	ORG	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	13	CK (B)	P203	16	♦	/	(*)	BRN/SH	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: TERMINAL BOARD PANEL E.I.C.: CW (B)	REV: 00 PAGE: 3 OF 3

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
CW (B)	TB3	13	EYJ (B)	J10	42	605[6]/09	2-1	2X16AWG	TH-38	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	15	CK (B)	P203	3	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	16	KB (B)	TB5	6	♦	/	16AWG	36ZA-2	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	16	CK (B)	P203	8	♦	/	(*)	BLK-BLU	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	17	EYJ (B)	J10	28	605[6]/09	2-1	16AWG	36PA-1	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	17	CK (B)	P203	9	♦	/	(*)	BLK-ORG	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	20	KB (B)	TB5	14	♦	/	16AWG	36VA-2	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
CW (B)	TB3	20	CK (B)	P203	7	♦	/	(*)	BLK-VIO	31A	11-3.35	B3	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

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MAINTENANCE TELEPHONE JACK

KE

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COOMUNICATION	SYSTEM CODE: 11 EQUIPMENT: MAINTENANCE TELEPHONE JACK E.I.C.: KE (A)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
KE (A)	1	1	EYP (A)	P11	AU	LVR/A	2-1	16AWG	34XA-1	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	1	1	KE (A)	2	1	LVR/A	2-1	16AWG	34XA-2	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	1	2	EYP (A)	P11	AT	LVR/A	2-1	16AWG	34ZA-1	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	1	2	KE (A)	2	2	LVR/A	2-1	16AWG	34ZA-2	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	2	1	KE (A)	1	1	LVR/A	2-1	16AWG	34XA-2	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	2	1	KE (A)	3	1	♦	/	16AWG	34XA-3	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	2	2	KE (A)	3	2	♦	/	16AWG	34ZA-3	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	2	2	KE (A)	1	2	LVR/A	2-1	16AWG	34ZA-2	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	3	1	KE (A)	2	1	♦	/	16AWG	34XA-3	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	3	1	KE (A)	4	1	♦	/	16AWG	34XA-4	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	3	2	KE (A)	2	2	♦	/	16AWG	34ZA-3	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	3	2	KE (A)	4	2	♦	/	16AWG	34ZA-4	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	4	1	KE (A)	3	1	♦	/	16AWG	34XA-4	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (A)	4	2	KE (A)	3	2	♦	/	16AWG	34ZA-4	42C	11-3.39	B(5-6)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: MAINTENANCE TELEPHONE JACK	E.I.C.: KE (B)	REV: 00	PAGE: 1 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
KE (B)	1	1	EYJ (B)	J11	AU	LVR/B	2-1	16AWG	34XA-1	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	1	1	KE (B)	2	1	701/06 LVR/B	2-6 2-1	16AWG	34XA-2	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	1	2	EYJ (B)	J11	AT	LVR/B	2-1	16AWG	34ZA-1	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	1	2	KE (B)	2	2	701/06 LVR/B	2-6 2-1	16AWG	34ZA-2	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	2	1	KE (B)	1	1	701/06 LVR/B	2-6 2-1	16AWG	34XA-2	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	2	1	KE (B)	3	1	701/06	2-6	16AWG	34XA-3	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	2	2	KE (B)	1	2	701/06 LVR/B	2-6 2-1	16AWG	34ZA-2	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	2	2	KE (B)	3	2	♦	/	16AWG	34ZA-3	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	3	1	KE (B)	2	1	701/06	2-6	16AWG	34XA-3	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	3	1	KE (B)	4	1	♦	/	16AWG	34XA-4	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	3	2	KE (B)	4	2	♦	/	16AWG	34ZA-4	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	3	2	KE (B)	2	2	♦	/	16AWG	34ZA-3	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	4	1	KE (B)	3	1	♦	/	16AWG	34XA-4	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	4	1	KE (B)	5	1	344/B/07	2-8	16AWG	34XA-5	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: MAINTENANCE TELEPHONE JACK	E.I.C.: KE (B)	REV: 00	PAGE: 2 OF 2

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
KE (B)	4	2	KE (B)	3	2	♦	/	16AWG	34ZA-4	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	4	2	KE (B)	5	2	344/B/07	2-8	16AWG	34ZA-5	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	5	1	KE (B)	4	1	344/B/07	2-8	16AWG	34XA-5	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449
KE (B)	5	2	KE (B)	4	2	344/B/07	2-8	16AWG	34ZA-5	42C	11-3.39	B(3-4)	N.A.	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES# 1400,1401,1403,1449

SWITCH RADIO

SM

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: SWITCH RADIO	E.I.C.: SM (A)	REV: 00	PAGE: 1 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	JA	1	CW (A)	TB1	18	♦	/	16AWG	35GA-3	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	JA	2	CW (A)	TB1	1	♦	/	16AWG	36AA-6	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	JA	3	CW (A)	TB1	2	♦	/	16AWG	NB43-12	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	JA	4	MX (A)	A21	/	♦	/	16AWG	G33	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	1	CF (A)	P205	/	♦	/	(*)	BRN-YEL	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	2	CF (A)	P205	/	♦	/	(*)	BRN-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	3	CF (A)	P205	/	♦	/	(*)	BRN-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	4	CF (A)	P205	/	♦	/	(*)	YEL-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	5	CF (A)	P205	/	♦	/	(*)	YEL-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	6	CF (A)	P205	/	♦	/	(*)	WHT-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	7	CF (A)	P205	/	♦	/	(*)	WHT-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	8	CF (A)	P205	/	♦	/	(*)	WHT-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	9	CF (A)	P205	/	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-J1	10	CF (A)	P205	/	♦	/	(*)	BRN-BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: SWITCH RADIO E.I.C.: SM (A)	REV: 00 PAGE: 2 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	SM1-J1	11	CF (A)	P205	/	♦	/	(*)	VIO SHIELD	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	1	CK (A)	P202	/	♦	/	(*)	BRN-YEL	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	2	CK (A)	P202	/	♦	/	(*)	BRN-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	3	CK (A)	P202	/	♦	/	(*)	BRN-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	4	CK (A)	P202	/	♦	/	(*)	YEL-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	5	CK (A)	P202	/	♦	/	(*)	YEL-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	6	CK (A)	P202	/	♦	/	(*)	WHT-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	7	CK (A)	P202	/	♦	/	(*)	WHT-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	8	CK (A)	P202	/	♦	/	(*)	WHT-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	9	CK (A)	P202	/	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	10	CK (A)	P202	/	♦	/	(*)	BRN-BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P1	11	CK (A)	P202	/	♦	/	(*)	VIO SHIELD	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	1	KR (A)	TB6	1	♦	/	(*)	BRN-YEL	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	2	KR (A)	TB6	2	♦	/	(*)	BRN-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: SWITCH RADIO	E.I.C.: SM (A)	REV: 00	PAGE: 3 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	SM1-P2	3	KR (A)	TB6	3	♦	/	(*)	BRN-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	4	KR (A)	TB6	4	♦	/	(*)	YEL-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	5	KR (A)	TB6	5	♦	/	(*)	YEL-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	6	KR (A)	TB6	6	♦	/	(*)	WHT-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	7	KR (A)	TB6	7	♦	/	(*)	WHT-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	8	KR (A)	TB6	8	♦	/	(*)	WHT-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	9	KR (A)	TB6	9	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	10	KR (A)	TB6	10	♦	/	(*)	BRN-BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM1-P2	11	KR (A)	TB6	11	♦	/	(*)	VIO SHIELD	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	1	CW (A)	TB3	2	♦	/	(*)	VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	2	CW (A)	TB3	3	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	3	CW (A)	TB3	4	♦	/	(*)	WHT	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	4	CW (A)	TB3	5	♦	/	(*)	BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	5	CW (A)	TB1	13	♦	/	(*)	BLK-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI

SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: SWITCH RADIO	E.I.C.: SM (A)	REV: 00	PAGE: 4 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	SM2-J1	6	CW (A)	TB1	14	♦	/	(*)	BLK-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	7	CW (A)	TB1	15	♦	/	(*)	BLK-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	8	CW (A)	TB3	6	♦	/	(*)	BLK-RED	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	9	CW (A)	TB3	7	♦	/	(*)	BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	10	CW (A)	TB3	8	♦	/	(*)	BLK-BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	11	CW (A)	TB1	12	♦	/	(*)	BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	13	CW (A)	TB3	9	♦	/	(*)	BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-J1	14	CW (A)	TB1	11	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	1	CK (A)	P203	4	♦	/	(*)	VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	2	CK (A)	P203	5	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	3	CK (A)	P203	11	♦	/	(*)	WHT	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	4	CK (A)	P203	10	♦	/	(*)	BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	5	CK (A)	P203	9	♦	/	(*)	BLK-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	6	CK (A)	P203	8	♦	/	(*)	BLK-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: SWITCH RADIO E.I.C.: SM (A)	REV: 00 PAGE: 5 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	SM2-P1	7	CK (A)	P203	7	♦	/	(*)	BLK-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	8	CK (A)	P203	19	♦	/	(*)	BLK-RED	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	9	CK (A)	P203	15	♦	/	(*)	BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	10	CK (A)	P203	12	♦	/	(*)	BLK-BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	11	CK (A)	P203	1	♦	/	(*)	BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	13	CK (A)	P203	16	♦	/	(*)	BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	14	CK (A)	P203	3	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	15	CK (A)	P203	14	♦	/	(*)	RED-GRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P1	16	CW (A)	TB3	10	♦	/	16AWG	35FA-10	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	1	KR (A)	TB7	2	♦	/	(*)	VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	2	KR (A)	TB7	3	♦	/	(*)	GRY	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	3	KR (A)	TB7	4	♦	/	(*)	WHT	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	4	KR (A)	TB7	5	♦	/	(*)	BLK	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	5	KR (A)	TB7	7	♦	/	(*)	BLK-ORG	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: SWITCH RADIO E.I.C.: SM (A)	REV: 00 PAGE: 6 OF 6

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
SM (A)	SM2-P2	6	KR (A)	TB7	8	♦	/	(*)	BLK-BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	7	KR (A)	TB7	9	♦	/	(*)	BLK-VIO	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	8	KR (A)	TB7	6	♦	/	(*)	BLK-RED	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	9	KR (A)	TB7	10	♦	/	(*)	BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	10	KR (A)	TB7	12	♦	/	(*)	BLK-BRN	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	11	KR (A)	TB7	1	♦	/	(*)	BLU	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	13	KR (A)	TB7	11	♦	/	(*)	BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449
SM (A)	SM2-P2	14	KR (A)	TB7	13	♦	/	(*)	BLK-BRN/SH	31A	11-3.35	(BC)6	N.A.	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES# 1400,1401,1403,1449

CODE CONTROL BOX (VETAG)

VE

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476			SAN FRANCISCO MUNI	
SYSTEM: COMMUNICATION	SYSTEM CODE: 11	EQUIPMENT: CODE CONTROL BOX (VETAG)	E.I.C.: VE (A)	REV: 00	PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
VE (A)	J2	1	KQ (A)	TB10	16	♦	/	16AWG	35QA-2	45	11-3.41	D(5-8)	N.A.	
VE (A)	J2	1	VE (A)	J2	12	♦	/	16AWG	35QA-3	45	11-3.41	D(5-8)	N.A.	
VE (A)	J2	3	KB (A)	NB AUX.	8	♦	/	16AWG	NB14	45	11-3.41	D(5-8)	N.A.	
VE (A)	J2	4	KQ (A)	TB10	15	♦	/	16AWG	35PA-2	45	11-3.41	D(5-8)	N.A.	
VE (A)	J2	14	KR (A)	TB3	2	♦	/	16AWG	46SA-1	27D	11-3.27	D6	N.A.	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES# 1400,1401,1403,1449
VE (A)	J2	16	KR (A)	TB3	11	♦	/	16AWG	46RA-1	27D	11-3.27	D6	N.A.	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES# 1400,1401,1403,1449

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Breda Costruzioni Ferroviarie	LRV2 INTEGRATED WIRING TABLES VEHICLES # 1400 THROUGH 1476	SAN FRANCISCO MUNI
SYSTEM: COMMUNICATION	SYSTEM CODE: 11 EQUIPMENT: CODE CONTROL BOX (VETAG) E.I.C.: VE (B)	REV: 00 PAGE: 1 OF 1

FROM EQUIPMENT			TO EQUIPMENT			RACEWAY		CABLE TYPE	WIRE ID	REFERENCES TO IWD				NOTE
DEVICE	TERM BOARD	PIN	DEVICE	TERM BOARD	PIN	ID	L.I. CODE			SHEET #	PAGE #	EQUIP LOC	SUB ASSEMBLY	
VE (B)	J2	1	KQ (B)	TB10	16	♦	/	16AWG	35QA-2	45	11-3.41	D(2-5)	N.A.	
VE (B)	J2	1	VE (B)	J2	12	♦	/	16AWG	35QA-3	45	11-3.41	D(2-5)	N.A.	
VE (B)	J2	3	KB (B)	NB AUX.	8	♦	/	16AWG	NB14	45	11-3.41	D(2-5)	N.A.	
VE (B)	J2	4	KQ (B)	TB10	15	♦	/	16AWG	35PA-2	45	11-3.41	D(2-5)	N.A.	
VE (B)	J2	14	EYJ (B)	J11	d	LVR/B	2-1	16AWG	46SA-1	27D	11-3.27	D2	N.A.	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES# 1400,1401,1403,1449
VE (B)	J2	16	EYJ (B)	J11	c	LVR/B	2-1	16AWG	46RA-1	27D	11-3.27	D2	N.A.	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES# 1400,1401,1403,1449

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11-3.6 Equipment Circuit Board Schematics (ECBS)

The COMMUNICATIONS SYSTEM Subsystem Equipment Circuit Board Schematics (ECBS) produced by TCS are provided in the following Diagrams/Schematics and listed in the following Table 11-3.5 ECBS LIST.

Each ECBS provides the Circuit Schematic of the relevant card to which the Schematic Title is referred.

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

The ECBS identified by both BCF File # and by Supplier File, are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).

The ECBS identified only by Supplier File # are collected immediately after those ECBS identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

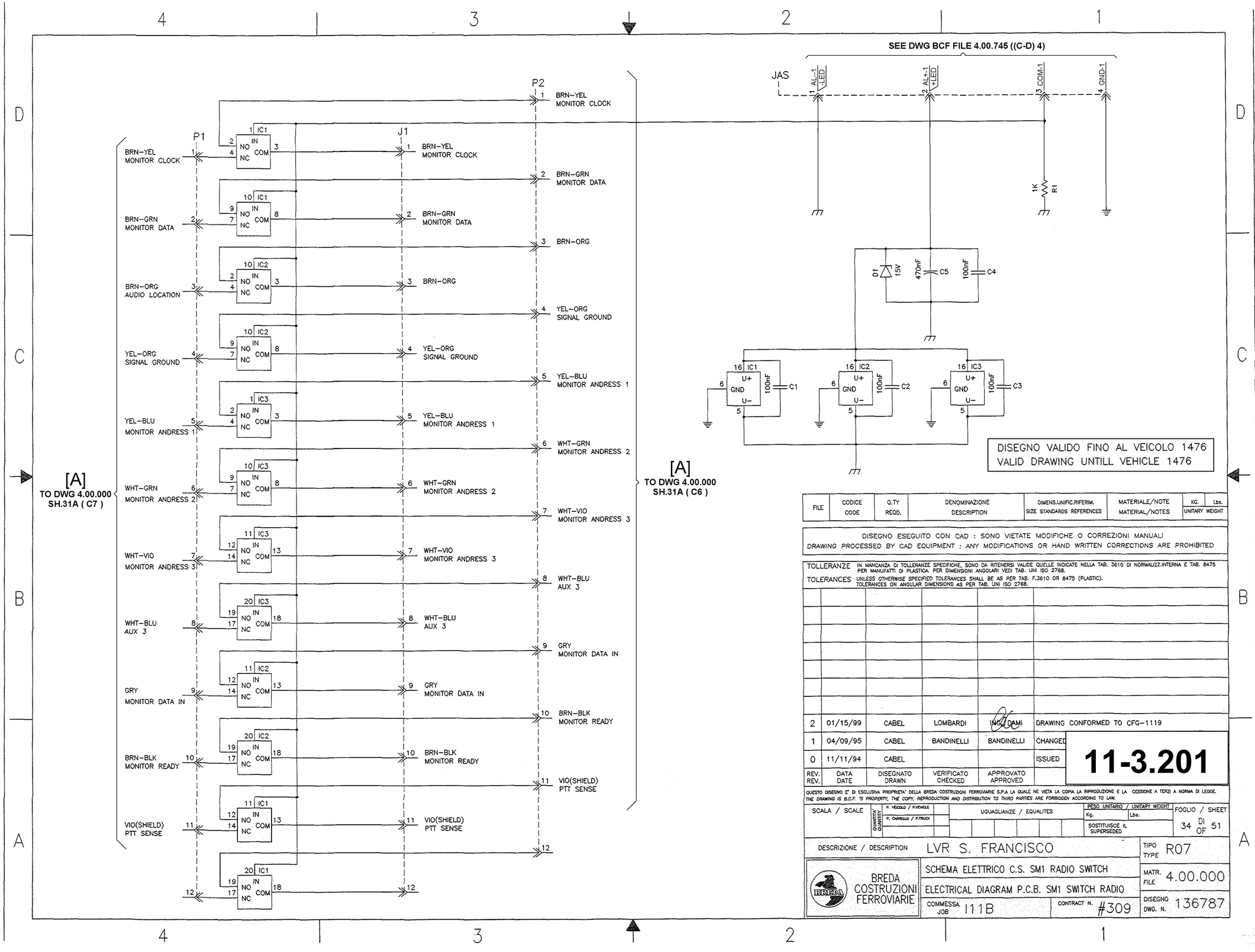
For Equipment Circuit Board Component Layout refer to the following para 11-3.7 where the relevant Equipment Circuit Board Component Layout (ECBCL) are collected.

Table 11-3.5 COMMUNICATIONS SYSTEM – ECBS LIST

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	NOTE
1	4.00.000 SH. 34	ELECTRICAL DIAGRAM P.C.B. SM1 SWITCH RADIO	11-3.201	
2	4.00.000 SH. 34A	ELECTRICAL DIAGRAM P.C.B. SM2 SWITCH RADIO	11-3.203	
3	4.00.232	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.49	This board schematic is included in the SIWD. DWG # 4.00.232 in para 11-3.4.
4	4.00.234 SH. 1 ---------- 35-4146 SH. 1	SCHEMATIC COMM. CONTROL PANEL	11-3.205	
5	4.00.234 SH. 2 ---------- 35-4146 SH. 2	SCHEMATIC COMM. CONTROL PANEL	11-3.207	
6	4.00.265 ---------- 35-4167	SCHEMATIC PA COMMUNICATION CONTROL BOARD	11-3.209	

Table 11-3.5 COMMUNICATIONS SYSTEM – ECBS LIST (cont'd)

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	NOTE
7	4.00.266 ---------- 35-4162	SCHEMATIC RADIO CONTROL / CHIME GENERATOR BOARD	11-3.211	
8	35-4008	SCHEMATIC DC TO DC CONVERTER	11-3.213	
9	35-4171	SCHEMATIC PASSENGER INTERCOM CONTROL BOARD	11-3.215	
10	35-4180	SCHEMATIC CAB INTERCOM CONTROL BOARD	11-3.217	
11	37-4041	SCHEMATIC POWER AMPLIFIER	11-3.219	



FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
2	01/15/99	CABEL	LOMBARDI	ING. DAMI	DRAWING CONFORMED TO CFG-1119
1	04/09/95	CABEL	BANDINELLI	BANDINELLI	CHANGED
0	11/11/94	CABEL			ISSUED

11-3.201

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

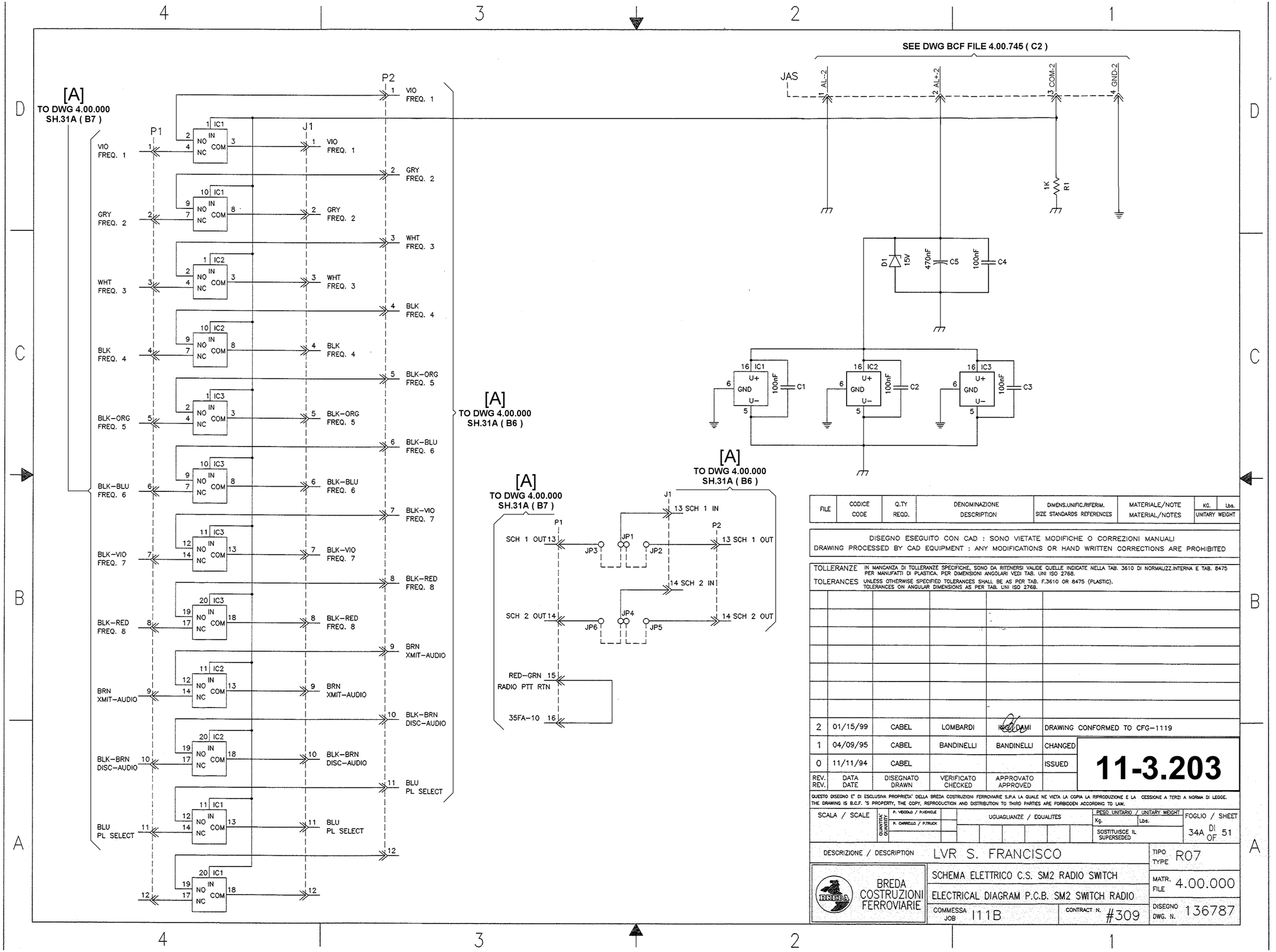
SCALA / SCALE — QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE, P. CARRELLO / P.TRUCK — UGUAGLIANZE / EQUALITES — PESO UNITARIO / UNITARY WEIGHT Kg. Lbs. — FOGLIO / SHEET 34 DI OF 51 — SOSTITUISCE IL SUPERSEDED

DESCRIZIONE / DESCRIPTION: LVR S. FRANCISCO
SCHEMA ELETTRICO C.S. SM1 RADIO SWITCH
ELECTRICAL DIAGRAM P.C.B. SM1 SWITCH RADIO

BREDA COSTRUZIONI FERROVIARIE

COMMESSA JOB 111B — CONTRACT N. #309

TIPO TYPE R07
MATR. FILE 4.00.000
DISEGNO DWG. N. 136787



FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG.	Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
2	01/15/99	CABEL	LOMBARDI	[illegible]DAMI	DRAWING CONFORMED TO CFG-1119
1	04/09/95	CABEL	BANDINELLI	BANDINELLI	CHANGED
0	11/11/94	CABEL			ISSUED

11-3.203

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE
QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK
UGUAGLIANZE / EQUALITES
PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.
SOSTITUISCE IL SUPERSEDED
FOGLIO / SHEET 34A DI OF 51

DESCRIZIONE / DESCRIPTION LVR S. FRANCISCO
TIPO TYPE R07
BREDA COSTRUZIONI FERROVIARIE
SCHEMA ELETTRICO C.S. SM2 RADIO SWITCH
ELECTRICAL DIAGRAM P.C.B. SM2 SWITCH RADIO
MATR. FILE 4.00.000
COMMESSA JOB 111B
CONTRACT N. #309
DISEGNO DWG. N. 136787

REVISIONS			
REV	DESCRIPTION	DATE	APPR
—	INITIAL RELEASE	12/92	KRH
A	REVISED & REDRAWN	1/93	BTB
B	REVISED & REDRAWN	5/94	JM
C	DELETED C24 AT U5D-8; DELETED +28 VSEL AT R3; +5V WAS HOLD AT U6A-4, U6B-10, U7B-10; SPARE WAS HOLD AR U7A-5; SWAPPED POSITIONS OF C2 AND C27.	6/94	JM
D	ADDED R40-42; ADDED C33-35	12/94	RCM
E	SHT 2: ADDED S4-2; U8 WAS LM258N, R21 WAS 46.4K.	4/95	KRH
F	ADDED K5 & S5 CIRCUITS; R3 WAS 150; S3 REMOVED NC SIDE; REMOVED SW PB FROM S1, S2, & S3; SHT 2: S4 WAS S4-1 AND S4-2	1/97	ALS

1 LINK 4146-02D.SCH

4. ALL DIODES ARE 1N4007.
3. ALL CAPACITORS ARE IN ufs, 20%, 50V.
2. ALL RESISTORS ARE 5%.
1. ALL RESISTORS ARE 1/4 W.

NOTES: UNLESS OTHERWISE SPECIFIED

I.C. MODULE POWER			
DEVICE		PIN NO.	
REF DES	TYPE	+5V	GND
U6, U7	556	14	7
U2, U3	74LS74	14	7
U4	74LS27	14	7
U5	74LS04	14	7
U1	74LS32	14	7

NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER FILE DISK.

35-1145 | DASH | NEXT ASSY | APPLICATION | LINK 4146-02B.SCH

	DRAWN	DATE
	KR HONIGMANN	11-9-92
	CHECKED	
	B.T.BLEACHER	1-25-93
	APPROVED	
	J.G. KIEL	
	CUST APPROVAL	

TRANSIT CONTROL SYSTEMS
A DIVISION OF THE ANELLO CORPORATION

TITLE: SCHEMATIC- COMM CONTROL PANEL

SIZE	FSCM	DWG NO.	REV
D		35-4146	F

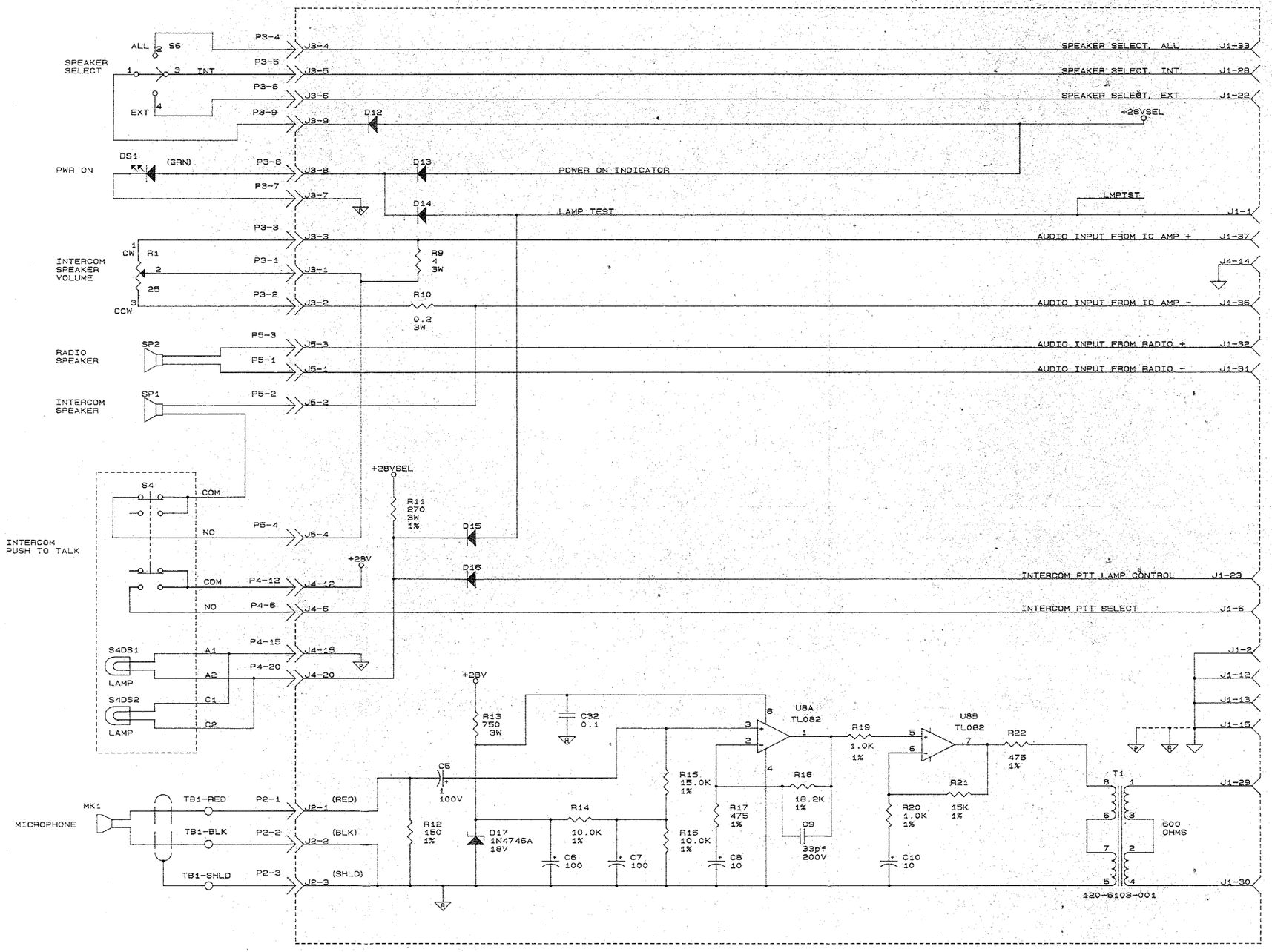
SCALE: NONE | SHEET 1 OF 2

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
MATR./FILE 4.00.234 TAV./SHEET 002
SEZ. ANCH./FILE SECTION DDP
FASE PROG./DESIGN STAGE
DOCUMENTAZIONE/EQUALITIES

11-3.205

LINK 4146-01D.SCH

REVISIONS			
REV	DESCRIPTION	DATE	APPR
	SEE SHT 1.		



BREDA COSTRUZIONI FERROVIARIE	
PROGETTO / TYPE	R07
MATR. / FILE 4.00.234	TAV. / SHEET 002
SEZ. ARCH. / FILE SECTION: DDP	FASE PROG. / DESIGN STAGE
UGUAGLIANZE / EQUALITES	

11-3.207

NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER FILE DISK.

SIZE	FSCM	DWG NO.	REV
D		35-4146	F
SCALE: NONE			SHEET 2 OF 2

REVISIONS			
REV	DESCRIPTION	DATE	APPR
—	INITIAL RELEASE	2-93	BC
A	ADDED P1-H AND U4-2 TO U4-5.	12-93	BC
B	AT D24, 1N5930B WAS 1N5353B.	2-94	JM
C	ADDED R65, R66, RELAY @ P1-10, D3C; DELETED D27; REVISED VALUES FOR R19, R20, R21, R29, R55, R56;	9/94	BC
D	REMOVED R63, R64; ADDED R67, R68, C29; R42, R43, R45, R47 WERE 10K.	1/95	BC
E	REVISED F/D ZENER DIODES. R68 WAS 470K. R67 WAS 220. MOVED R67 TO CATHODE OF D20.	3/95	KRH
F	ADDED C30 AND D27	12/95	ALS
G	P1-N WAS INT, P1-R WAS EXT, P1-12 WAS INT, P1-14 WAS EXT. P1-18 WAS TO INT. P1-19 WAS TO EXT	1/97	ALS

BREDA COSTRUZIONI FERROVIARIE		
PROGETTO / TYPE	R07	
MATR. / FILE	4.00.265	TAV. / SHEET 001
SEZ. ARCH. / FILE SECTION	DDP	FASE PROG. / DESIGN STAGE
UGUAGLIATORI / EQUALITIES		

RELAYS			
REF DES	RELAY	CONTACT	FUNCTION
K2	KPA	2'C'	PA MODE
K3	KPPA	2'C'	PASS PA MODE
K4	KRPA	4'C'	RADIO/PA MODE
K1	KATCS	2'C'	ATCS MODE

4. ALL DIODES ARE 1N4007.
3. ALL CAPACITORS ARE IN uF'S, 10%.
2. ALL CAPACITORS ARE 100V.
1. ALL RESISTORS ARE 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

NOTE
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		DRAWN B.LECHNER	2-2-93
		CHECKED B. BLEACHER	2-93
		APPROVED JOHN G. KIEL	
		CUST APPROVAL	
	35-1166		
DASH	NEXT ASSY		
APPLICATION			

TRANSIT CONTROL SYSTEMS
TUSTIN, CALIFORNIA

TITLE: SCHEMATIC- PA COMMUNICATION CONTROL BOARD

SIZE	FSCM	DWG NO.	REV
D		35-4167	G
SCALE: NONE		SHEET 1 OF 1	

11-3.209

REVISIONS			
REV	DESCRIPTION	DATE	APPR
-	INITIAL RELEASE	2-93	BC
A	ADDED P1-F, KDCC AND D12.	12-93	BC
B	ADDED Q2, Q3, R30, R31, R32, C16 ADDED NOTE 6 & RADIO GROUNDS; ADDED P1-19 THRU -21; AT P1-E DID SAY "FROM PA AUDIO TRANSFORMER"	9/94	BC
C	MOVED K1F (KDCC) IN SERIES WITH K2D (KMC), ADDED K1B (KDCC) TO GROUND CONNECTED D12 TO P1-F AND R1	6-96	ALS
D	REVISED R28, WAS 3.3K; REVISED "RADIO VOLUME" AND "RADIO SQUELCH" POTS. WERE 2.5K	3/98	JSD

RELAYS			
REF DES	RELAY	CONTACT	FUNCTION
K1	KDCC	2'C'	DOOR CLOSURE CHIME
K2	KMC	4'C'	INTERCOM SPEAKER (MONITOR) CHIME
K3	KDIRB	2'C'	DIRECTION T/L B-END

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE 1/4W, 5%.
2. ALL CAPACITORS ARE 100V.
3. ALL CAPACITORS ARE IN uf'S, 10%.
4. ALL DIODES ARE 1N4007.
5. [5] NOT INCLUDED ON 35-1159 PRINTED WIRING ASSEMBLY.
6. RADIO GROUND.

NOTE
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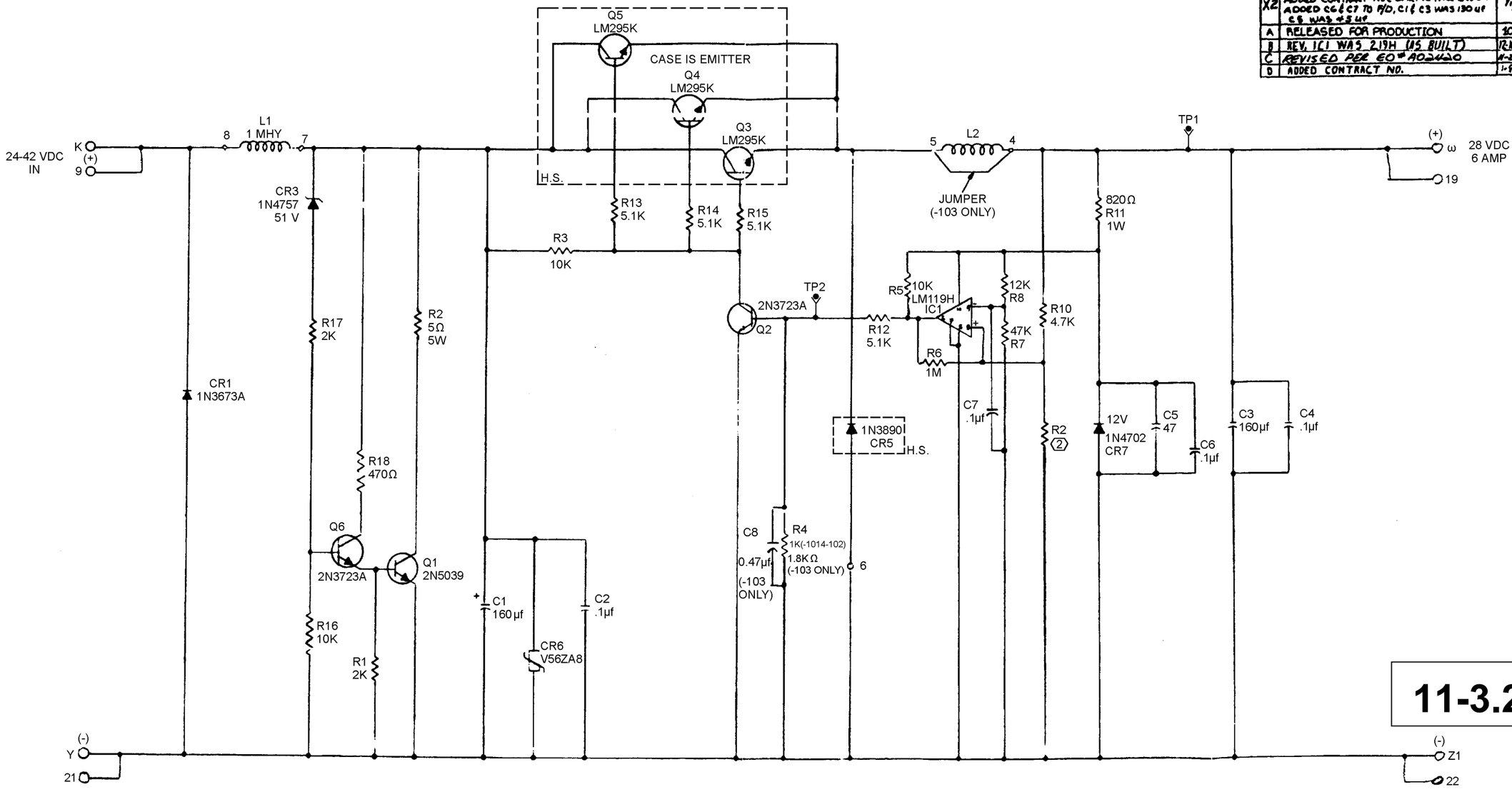
	DRAWN B. LECHNER	DATE 1/27/93	TRANSIT CONTROL SYSTEMS A DIVISION OF THE ANELLO CORPORATION
	CHECKED		TITLE: SCHEMATIC- RADIO CONTROL/CHIME GENERATOR BOARD
	APPROVED J.G. KIEL		
	CUST APPROVAL		SIZE D; FSCM; DWG NO. 35-4162; REV D
35-1159			SCALE: NONE; SHEET 1 OF 1
DASH NEXT ASSY			
APPLICATION			

11-3.211

P1 connector pinout (CONNECTOR EDGE44):

P1-1	1	1	A	23	P1-A
P1-2	2	2	B	24	P1-B
P1-3	3	3	C	25	P1-C
	X 4	4	D	26	X
	X 5	5	E	27	P1-E
P1-6	6	6	F	28	P1-F
P1-7	7	7	G	29	P1-H
P1-8	8	8	H	30	P1-J
P1-9	9	9	J	31	P1-K
P1-10	10	10	K	32	P1-L
	X 11	11	L	33	X
P1-12	12	12	M	34	P1-N
P1-13	13	13	N	35	P1-P
P1-14	14	14	P	36	P1-R
P1-15	15	15	R	37	P1-S
P1-16	16	16	S	38	P1-T
P1-17	17	17	T	39	X
P1-18	18	18	U	40	P1-V
P1-19	19	19	V	41	P1-W
P1-20	20	20	W	42	P1-X
P1-21	21	21	X	43	P1-Y
	X 22	22	Z	44	P1-Z

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
-	RELEASED	1/31/80	JRR
X1	RELEASE FOR PROTOTYPE (BART)	1/29/82	[illegible]
X2	AS BUILT RECORD ONLY CHG. ADDED CONTRACT NOS BART TO TITLE BLOCK ADDED C6 & C7 TO P/O, C1 & C3 WAS 130 uf C8 WAS .5 uf	9/1/86	[illegible]
A	RELEASED FOR PRODUCTION	10/3/86	[illegible]
B	REV. IC1 WAS 219H (AS BUILT)	12-16-88	[illegible]
C	REVISED PER EO# A02420	4-28-92	[illegible]
D	ADDED CONTRACT NO.	1-9-93	[illegible]



11-3.213

(2) TEST SELECT, APPROX. VALUE 2.2K

1. RESISTOR VALUES ARE IN OHMS ± 5% AND 1/2 W.

NOTES: UNLESS OTHERWISE SPECIFIED

ITEM NO.	PART OR IDENTIFYING	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
		PARTS LIST LIST OF MATERIAL		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
X DECIMAL ±
XX DECIMAL ±
XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

DRAWN [illegible] 1/31, 80
CHECKED
APPD
APPD
APPROVAL
CUST. APPROVAL

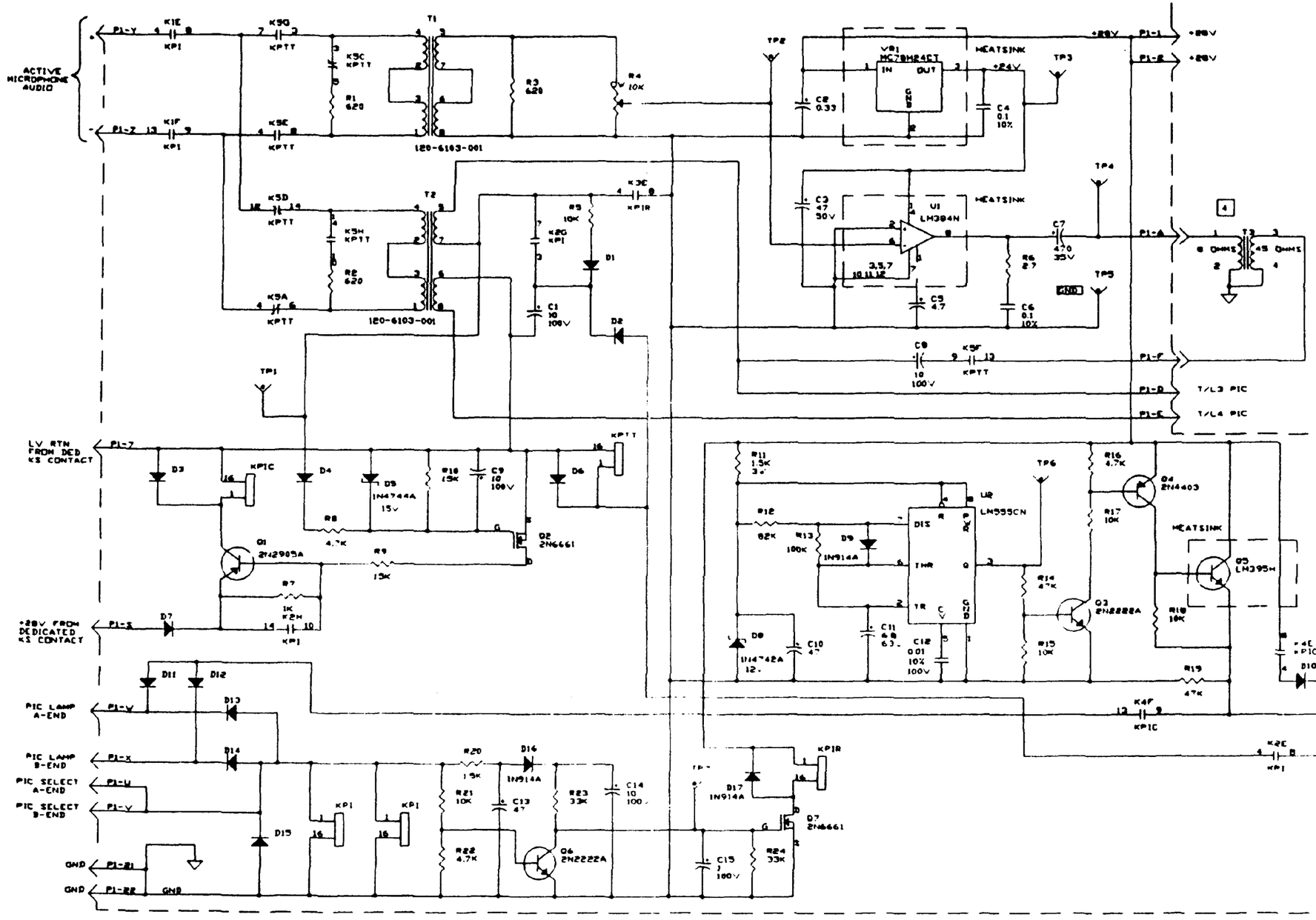
TRANSIT CONTROL SYSTEMS

TITLE
SCHEMATIC
DC-TO-DC CONVERTER
28 V

DASH 35-1018
NEXT ASSY
APPLICATION
BART
92AA-110 & 92DA-110

D 35-4008 D
Sheet 1 of 1

REVISIONS			
REV	DESCRIPTION	DATE	APPR
-	INITIAL RELEASE	1/93	BYB
A	REVISED FOR -102 CONFIG PCB		



RELAYS			
REF DES	RELAY	CONTACT	FUNCTION
K1	KP1	2'C'	PASS IC SELECT
K2	KP1	4'C'	PASS IC SELECT
K4	KPIC	2'C'	PASS IC CALL
K3	KP1R	2'C'	PASS IC RELEASE
K5	KPTT	4'C'	PASS PUSH-TO-TALK

4. NOT INCLUDED ON 35-1170 PRINTED WIRING ASSEMBLY.
3. ALL DIODES ARE 1N4007.
2. ALL CAPACITORS ARE IN uF'S, 20%, 50V
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.

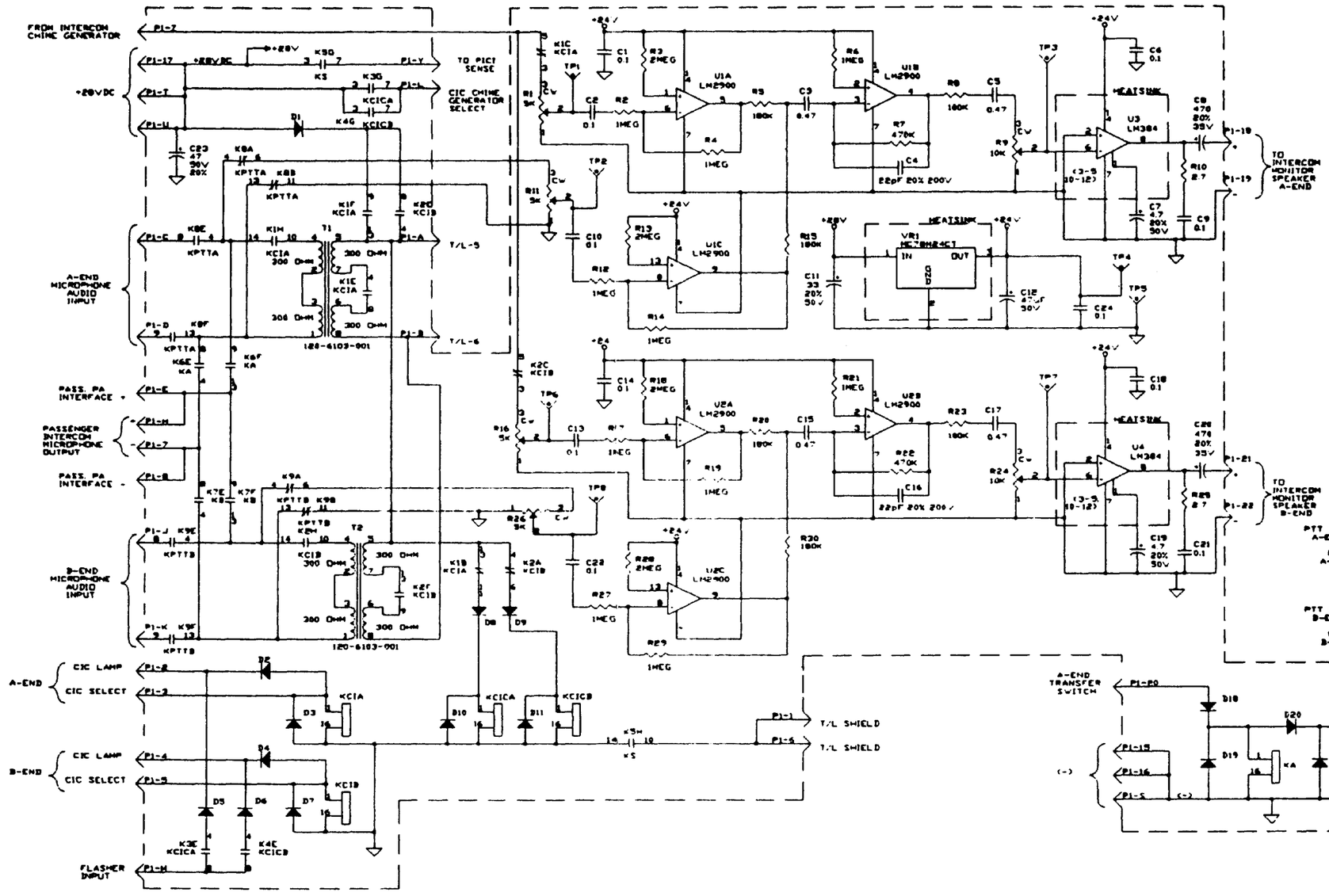
NOTES: UNLESS OTHERWISE SPECIFIED.

NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER FILE DISK.

11-3.215

		DRAWN: BLECHNER 1/19/93	TRANSIT CONTROL SYSTEMS, TUSTIN CALIFORNIA
		CHECKED	TITLE: SCHEMATIC- PASSENGER INTERCOM CONTROL BOARD
		APPROVED	
	35-1170	CUST APPROVAL: JG KIEL	SIZE: D; PSCM; DWG NO.: 35-4171; REV: A
DASH	NEXT ASSY	CONTRACT NO.	SCALE: NONE; SHEET 1 OF 1
APPLICATION			

REVISIONS			
REV	DESCRIPTION	DATE	APPR
-	INITIAL RELEASE	8-93	DTB
A	DEL KCIA-NO AT T1-L KCIB AT T2-1. KCIA-NC AT R1 WAS KCICA-NO. KCIB-NC AT R16 WAS KCICB-NO.	12/93	BC
B	REVISED TO REFLECT EO 939117988.		



RELAYS			
REF DES	RELAY	CONTACT	FUNCTION
K1	KCIA	4'C'	CIC MODE, A-END
K2	KCIB	4'C'	CIC MODE, B-END
K3	KCICA	4'C	CIC CALL A-END
K4	KCICB	4'C'	CIC CALL, B-END
K5	KS	4'C'	TRANSFER SWITCH ON
K6	KA	2'C'	TRANSFER SWITCH A-END
K7	KB	2'C'	TRANSFER SWITCH B-END
K8	KPTTA	2'C'	PUSH-TO-TALK A-END
K9	KPTTB	2'C'	PUSH-TO-TALK B-END

3. ALL DIODES ARE IN4007.
2. ALL CAPACITORS ARE IN uF'S, 50V, 10%.
1. ALL RESISTORS ARE 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

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NOTE

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		DRAWN BLECHNER	DATE 2-8-93	TRANSIT CONTROL SYSTEMS A DIVISION OF THE ANELLO CORPORATION
		CHECKED B BLEACHER	8-93	TITLE: SCHEMATIC CAB INTERCOM CONTROL BOARD
		APPROVED JOHN G. KIEL		
		CUST APPROVAL		SIZE D / FSCM / DWG NO. 35-4180 / REV B
	35-1179			SCALE: NONE / SHEET 1 OF 1
DASH	NEXT ASSY			
APPLICATION				

11-3.217

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
NC	RELEASED	11/...	
A	PIN V WAS PIN X ZONE B8	2/11/...	
X1	RELEASE FOR PRODUCTION (BART)	4/26/61	
X2	PIN V WAS PIN W, PIN W WAS PIN X	7/21/...	
X3	ADDED NOTE 5	8/31/...	
X4	ADDED ... TO TITLE BLOCK	9/1/...	
B	RELEASED FOR PRODUCTION	12/...	
C	ADDED CONTRACT NO.	1/...	

BALANCE
R4 100K 1/4W
R5 68K
R10 22K
C3 12pf
Q3 2N4235
R14 100Ω
CR3
CR1
CR2
Q5 2N3904
R38 1K
Q9 2N4238
2N3055
A (+)
C
B
D
R22 100Ω
R28 .1Ω 5W
C1 1µf 25V
Q1 2N3904
V
N
P
H
R6 33K
R11 4.7K
R15 27Ω
R29 .1Ω 5W
C7 .1µf
C8 .22µf
R32 10K
Q6 2N3906
R23 1K
CR4
2N4235 Q10
F
E
C4 10µf 16V
R16 100Ω
R17 1K
R24 100Ω
R33 6.8K
R36 10Ω
2N3055
J
K
R41 1K
R40 1K
R2 1K
R3 1K
R1 10K 70.7 V ADJUST
T1
R
R12 22K
BAL.
R7 100K 1/4W
Q4 2N4235
C5 12pf
R18 100Ω
CR7
CR5
CR6
Q7 2N3904
R39 1K
Q11 2N4238
2N3055
Y
Z
U
R8 68K
C2 1µf 25V
Q2 2N3904
W
R25 100Ω
R30 .1Ω 5W
C9 .1µf
R31 .1Ω 5W
R34 10K
C10 .22µf
R19 27Ω
R13 4.7K
Q8 2N3906
R26 1K
CR8
R9 33K
C6 10µf 16V
R20 100Ω
Q12 2N4235
S
T
R21 1K
R27 100Ω
R35 6.8K
R37 10Ω
2N3055
JW1
(-)
5 C 2000 µf
3 T 70.7V

4. ALL DIODES ARE 1N4007.
3 COMPONENT REF. DESIG. FOR SCHEMATIC ONLY COMPONENTS LOCATED OFF BOARD.
2. ALL RESISTORS 1/2 W, ± 5%
1. ALL CAPACITOR VOLTAGES NOT NOTED 100V MIN.

NOTE: UNLESS OTHERWISE SPECIFIED.

5 R40 & R41 ARE REPLACED WITH JUMPERS FOR - 102 ASSEMBLY

11-3.219

DASH	DASH	DASH	DASH	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
QTY REQD PER ASSY					PARTS LIST / LIST OF MATERIAL			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
X DECIMAL ±
.XX DECIMAL ±
.XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

DRAWN S ...
CHECKED J D ...
APPROVAL ...
APPROVAL
APPROVAL

37-1040-102
37-1040-101
DASH NEXT ASSY
APPLICATION
BART

CONTRACT NO. 42AA-110 & 42EA-110

TITLE
SCHEMATIC, POWER AMPLIFIER

SIZE D | CODE IDENT NO. | 37-4041 C
SCALE — | SHEET 1 OF 1

11-3.7 Equipment Circuit Board Components Layout (ECBCL)

The COMMUNICATION SYSTEM Subsystem Equipment Circuit Board Component Layout produced by TCS are provided in the following Diagrams/Schematics and listed in the following Table 11-3.6 ECBCL LIST.

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) "finding" and /or "putting back", on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

The ECBCL , identified by both BCF File # and by Supplier File, # are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).
The ECBCL identified only by Supplier File, # are collected immediately after those ECBCL identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).
For Equipment Circuit Board Schematics refer to the previous para 11-3.6 where the relevant Equipment Circuit Board Schematics (ECBS) are collected.

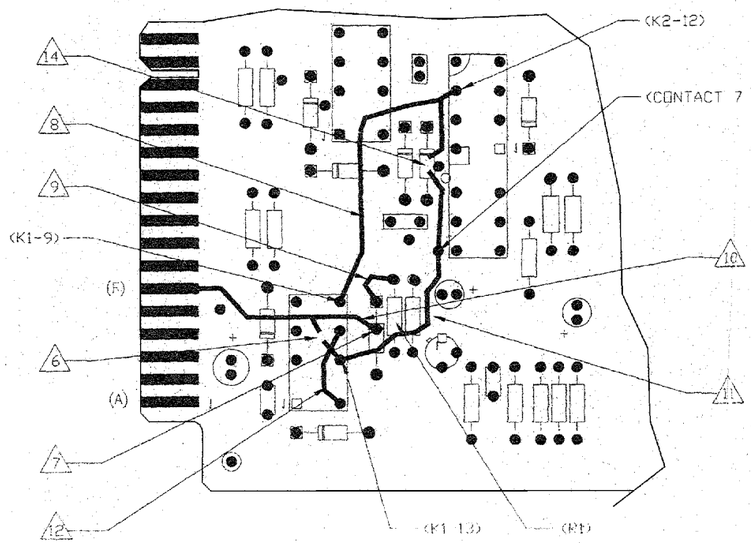
Table 11-3.6 COMMUNICATION SYSTEM – ECBCL LIST

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	NOTE
1	4.66.128 SH. 1 ---------- 35-1159	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.223	
2	4.66.128 SH. 2 ---------- PL 35-1159 SH. 1	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.225	
3	4.66.128 SH. 3 ---------- PL 35-1159 SH. 2	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.227	
4	4.66.128 SH. 4 ---------- PL 35-1159 SH. 3	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.229	
5	4.66.170 SH. 1 ---------- 35-1151	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.231	
6	4.66.170 SH. 2 ---------- PL 35-1151 SH. 1	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.233	
7	4.66.170 SH. 3 ---------- PL 35-1151 SH. 2	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.235	
8	4.66.170 SH. 4 ---------- PL 35-1151 SH. 3	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.237	

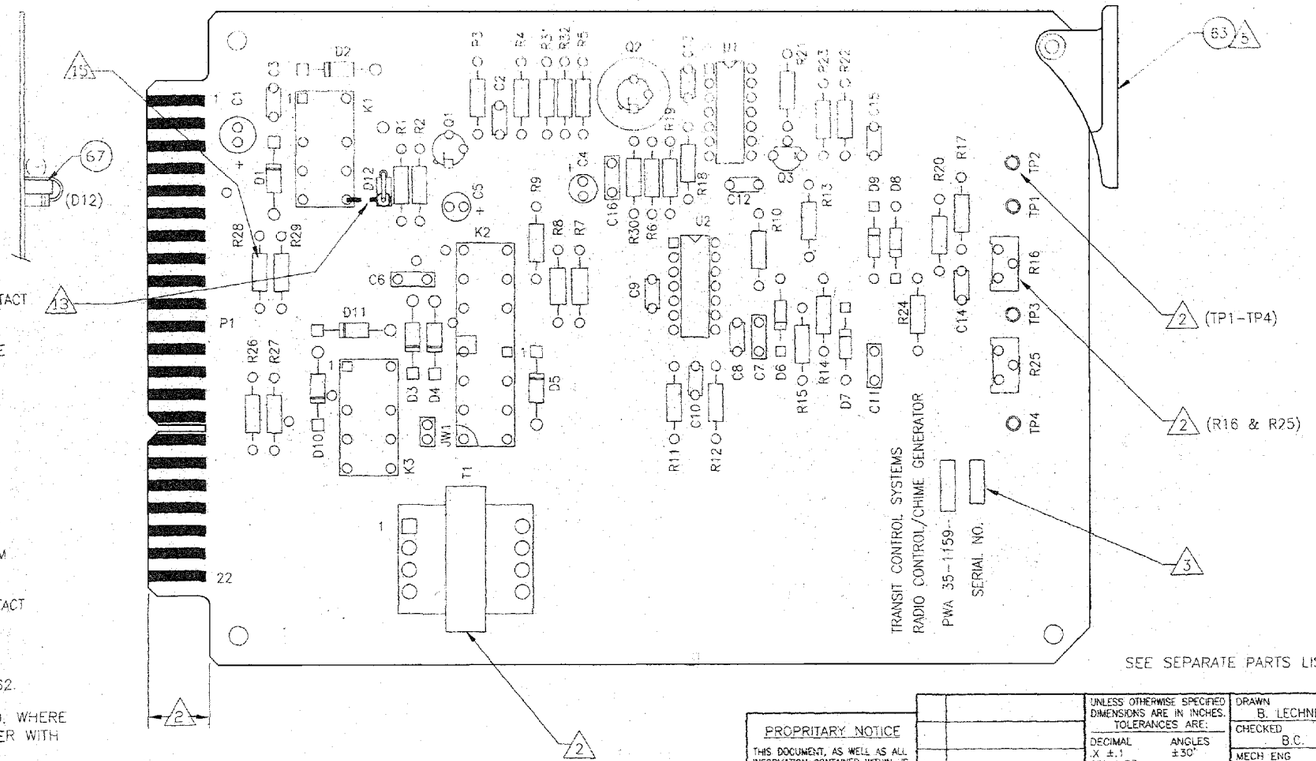
Table 11-3.6 COMMUNICATION SYSTEM – ECBCL LIST (cont'd)

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	NOTE
9	4.66.171 ---------- 35-1018	ASSEMBLY – 28V DC-TO-DC CONVERTER	11-3.239	
10	4.94.360	P.C.B. LAYOUT	11-3.241	
11	10-1310	ASSEMBLY PASSENGER INTERCOM P.C.B.	11-3.243	
12	PL 10-1310 SH. 3	ASSEMBLY PASSENGER INTERCOM P.C.B. – PARTS LIST	11-3.245	
13	PL 10-1310 SH. 4	ASSEMBLY PASSENGER INTERCOM P.C.B. – PARTS LIST	11-3.247	
14	PL 10-1310 SH. 5	ASSEMBLY PASSENGER INTERCOM P.C.B. – PARTS LIST	11-3.249	
15	35-1166	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD	11-3.251	
16	PL 35-1166 SH. 2	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD – PARTS LIST	11-3.253	
17	PL 35-1166 SH. 3	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD – PARTS LIST	11-3.255	
18	PL 35-1166 SH. 4	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD – PARTS LIST	11-3.257	
19	35-1170	PRINTED WIRING ASSEMBLY PASS INTERCOM CONTROL BD	11-3.259	
20	PL 35-1170 SH. 2	PRINTED WIRING ASSEMBLY PASS INTERCOM CONTROL BD – PARTS LIST	11-3.261	
21	PL 35-1170 SH. 3	PRINTED WIRING ASSEMBLY PASS INTERCOM CONTROL BD – PARTS LIST	11-3.263	
22	35-1179	PRINTED WIRING ASSEMBLY CAB INTERCOM CONTROL BD	11-3.265	
23	PL 35-1179 SH. 2	PRINTED WIRING ASSEMBLY CAB INTERCOM CONTROL BD – PARTS LIST	11-3.267	
24	PL 35-1179 SH.3	PRINTED WIRING ASSEMBLY CAB INTERCOM CONTROL BD – PARTS LIST	11-3.269	
25	37-1040	ASSEMBLY POWER AMPLIFIER	11-3.271	

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE	2-12-93	BC
A	ADDED D12 AND JUMPERS.	12-6-93	BC
B	CREATED -102 CONFIG	9-29-94	BC
C	CREATED -103 CONFIG. ITEM 2 WAS 1.	4-20-95	KRH
D	ADDED NOTES 6 THRU 14, ADDED SOLDER SIDE VIEW, ADDED ITEM 67, ADDED NEXT ASSY -105 (AS BUILT)	8/21/96	RY



SOLDER SIDE
(SILKSCREEN SHOWN FOR CLARITY)



COMPONENT SIDE

SEE SEPARATE PARTS LIST

4. CUT TRACE APPROXIMATELY WHERE SHOWN, BETWEEN CONTACT 7 PAD AND K2-12.

13. CUT TRACE BETWEEN K1-9 AND D12 ON COMPONENT SIDE

12. ADD JUMPER FROM K1-11 TO K1-16

11. ADD JUMPER FROM CONTACT 7 (PAD) TO K1-13

10. ADD JUMPER FROM CONTACT F TO D12

9. ADD JUMPER FROM R1 TO D12

8. ADD JUMPER FROM K2-12 TO K1-9

7. DRILL NEW HOLE FOR D12. INSTALL RESISTOR MOUNT (ITEM 67) AND INSTALL D12 TO ITEM 67.

6. CUT TRACE APPROXIMATELY WHERE SHOWN, BETWEEN CONTACT F AND K1-13.

5. INSTALL AFTER CONFORMAL COATING.

4. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 35-4162.

3. RUBBER STAMP ASSEMBLY DASH NO. AND SERIAL NO. WHERE SHOWN USING .12 CHARACTERS, COLOR BLACK. COVER WITH CLEAR LACQUER.

2. DO NOT APPLY CONFORMAL COAT TO COMPONENTS INDICATED.

1. CONFORMAL COAT BOTH SIDES OF CLEANED PRINTED WIRING ASSEMBLY PER MIL-STD-275 AFTER TESTING.

NOTES: UNLESS OTHERWISE SPECIFIED

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
MATR./FILE 4.66.128 TAV./SHEET 001
SEZ. ARCH./FILE SECTION DDP
FASE PROG./DESIGN STAGE
UGUAGLIANZE / EQUALITES

11-3.223

PROPRIETARY NOTICE

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NOTE

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DASH	35-1160
NEXT ASSY	
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMAL: .X ±.1, XX ±.03, .XXX ±.015
ANGLES ±30'
FRACTIONS ±1/16

HOLE DIAMETERS: .009/.125 +.004 -.001; .126/.250 +.005 -.001; .251/.500 +.006 -.001; .501/.750 +.008 -.001; .751/1.000 +.010 -.001; 1.001/2.000 +.012 -.001

DO NOT SCALE DRAWING

		DATE
DRAWN	B. LECHNER	2-12-93
CHECKED	B.C.	2-12-93
MECH ENG		
ELECT ENG	B.T. BLEACHER	2-12-93
PROD ENG		
CHIEF ENG	JOHN G. KIEL	
CUST. APPROVAL		
CONTRACT NO.		

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE
PRINTED WIRING ASSEMBLY
RADIO CNTL/CHIME GEN BD

SIZE	CODE IDENT NO.		REV.
D		35-1159	D

SCALE 2/1 | PLOT SCALE: 1/1 | SHEET 1 OF 1

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
-	INITIAL RELEASE	2-2-93	BTB
A	ADDED D12 TO ITEM 25, QTY WAS 7	12-6-93	JM
B	CREATED -102 CONFIG; ADDED ITEM 2, 23, 56, 57 ITEM 22 QTY WAS 1; ITEM 33 QTY WAS 2; ITEM 46 QTY WAS 2. (EO's 35P159A1, 35P159A2 ITEM 23 P/N WAS MP6661; ADDED ITEM 66	9-28-94	BC
C	CREATED -102 CONFIG	4-19-95	KRH
D	REMOVED CONFIG -101, WAS SAME AS -103 WITH EXCEPTION OF ITEM 1 P/N 35-2175-1 NOW REMOVED. ADDED CONFIG -105, ITEM 67, ITEM 68		
E	ADDED CONFIG -106, SAME AS -105 WITH THE FOLLOWING CHANGE: R28 IS ITEM 46 RC07G103JS WAS ITEM 44 RC07G332JS	3-11-98	SW

BREDA COSTRUZIONI FERROVIARIE

PROGETTO / TYPE R07

MATR. / FILE 4.66.128 TAV. / SHEET 002

SEZ. ARCH. / FILE SECTION DDP

FASE PROG. / DESIGN STAGE

UGUAGLIANZE / EQUALITES

11-3.225

NOTES: UNLESS OTHERWISE SPECIFIED

		DRAWN: B. LECHNER	DATE: 2-2-93
		CHECKED: B.C.	2-2-93
		ENGINEER: B. LECHNER	2-2-93
103	35-1160	CHIEF ENG: J.G.KIEL	
DASH	NEXT ASSY		
APPLICATION			

TRANSIT CONTROL SYSTEMS

TITLE: RADIO CONTROL/CHIME GENERATOR BOARD ASSEMBLY PARTS LIST

SIZE	CODE IDENT NO.	PART LIST NO.	REV.
A		PL 35-1159	E

SCALE: NONE SHEET 1 OF 3

TRANSIT CONTROL SYSTEMS	TITLE: RADIO CONTROL/CHIME GENERATOR BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1159	REV. E	ADVANCE ____ RELEASE X
				SHEET 2 OF 3

ITEM NO.	QTY REQD -102	-103	-105	-106	PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
1								
2	1	1	1	1	35-2175-2		PWB, RADIO CONTROL/CHIME GEN. BOARD	
3	REF	REF	REF	REF	35-4162		SCH, RADIO CONTROL/CHIME GEN. BOARD	
4								
5								
6								
7								
8								
9								
10								
11	1	1	1	1	LM224N	U1	IC, OPERATIONAL AMP	NATIONAL
12	1	1	1	1	LM556CN	U2	IC, DUAL TIMER	NATIONAL
13								
14								
15								
16	1	1	1	1	AZ830-4C-24DEA	K2	RELAY, MINIATURE 24V 4PDT 4'C'	AMER. ZETTLER
17	2	2	2	2	AZ830-2C-24DSE	K1,K3	RELAY, HIGH SENSITIVITY 24V DPDT 2'C'	AMER. ZETTLER
18								
19	1	1	1	1	120-6103-001	T1	TRANSFORMER, AUDIO	TCS
20								
21								
22	2	2	2	2	2N2222A	Q1,Q2	TRANSISTOR	
23	1	1	1	1	MPF6661	Q3	TRANSISTOR, FET, SWITCHING	
24	4	4	4	4	1N914A	D6,D7,D8,D9	DIODE, RECTIFIER	
25	8	8	8	8	1N4007	D1-D5,D10,D11,D12	DIODE, RECTIFIER	
26								
27	4	4	4	4	CKR05BX102KR	C2,C8,C9,C10	CAP, CERAMIC, .001uF 200V, 10%	
28	1	1	1	1	CKR05BX222KR	C12	CAP, CERAMIC, .0022uF 100V, 10%	
29	4	4	4	4	CKR05BX104KR	C3,C13,C14,C15	CAP, CERAMIC, .1uF 100V, 10%	
30	1	1	1	1	CKR06BX474KR	C7	CAP, CERAMIC, .47uF 50V, 10%	
31	3	3	3	3	CKR06BX105KR	C6,C11,C16	CAP, CERAMIC, 1uF 50V, 10%	
32								
33	1	1	1	1	515D475M050JA6A	C5	CAP, ALUM. ELECT, 4.7uF 50V, 20%	SPRAGUE
34	1	1	1	1	515D106M050JA6A	C4	CAP, ALUM. ELECT, 10uF 50V, 20%	SPRAGUE
35	1	1	1	1	515D476M050AA6A	C1	CAP, ALUM. ELECT, 47uF 50V, 20%	SPRAGUE
36								
37								

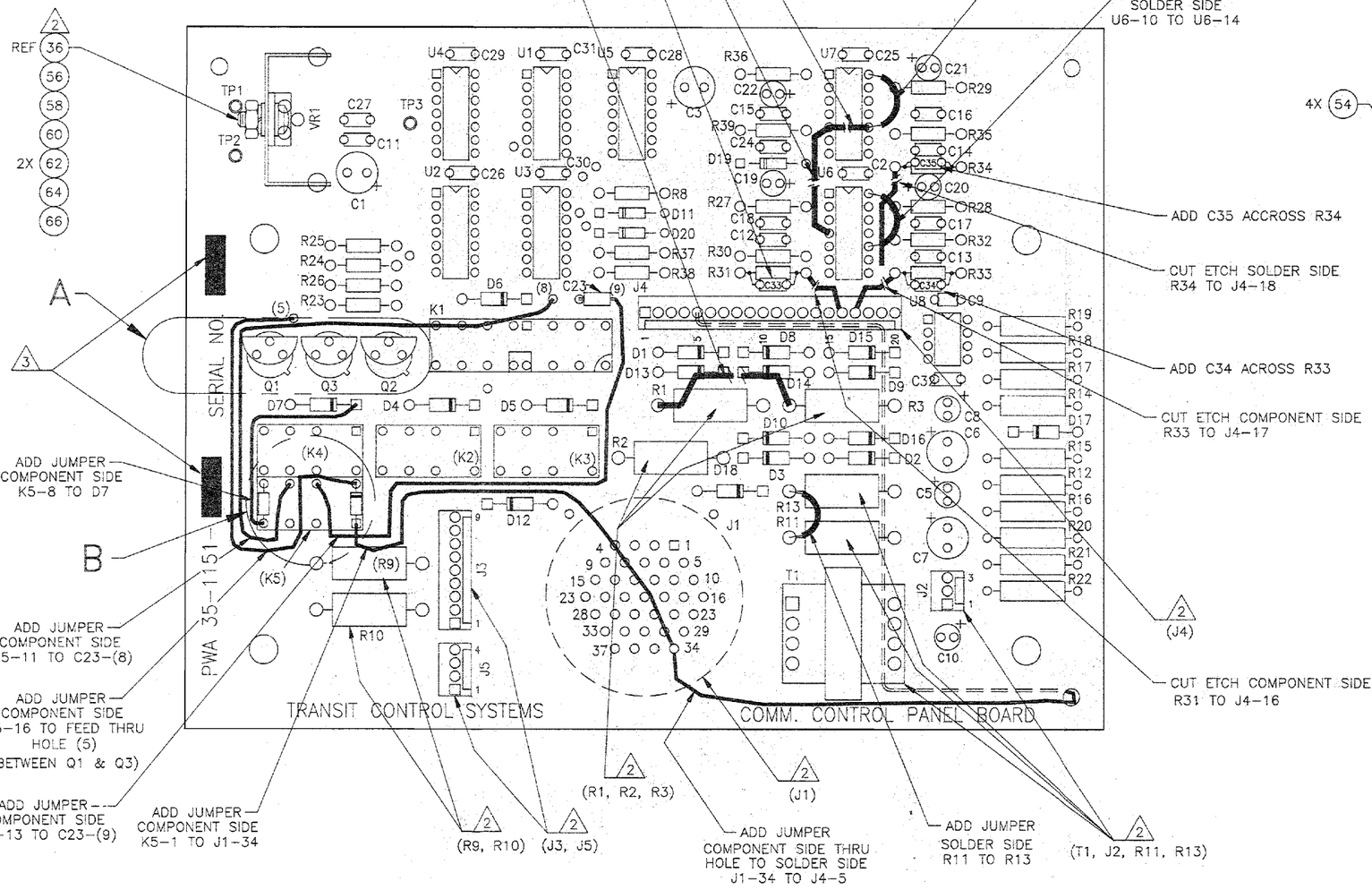
BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
MATR./FILE 4.66.128 TAV./SHEET 003
SEZ. ARCH./FILE SECTION DDP
FASE PROG./DESIGN STAGE
UGUAGLIANZE / EQUALITES

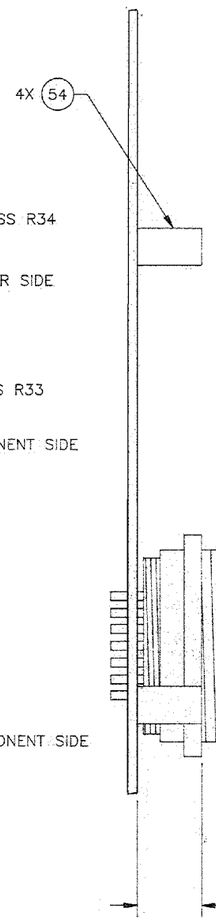
TRANSIT CONTROL SYSTEMS	TITLE: PA RADIO CONTROL/CHIME GENERATOR BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1159	REV. E	ADVANCE ____ RELEASE _X_ SHEET 3 OF 3

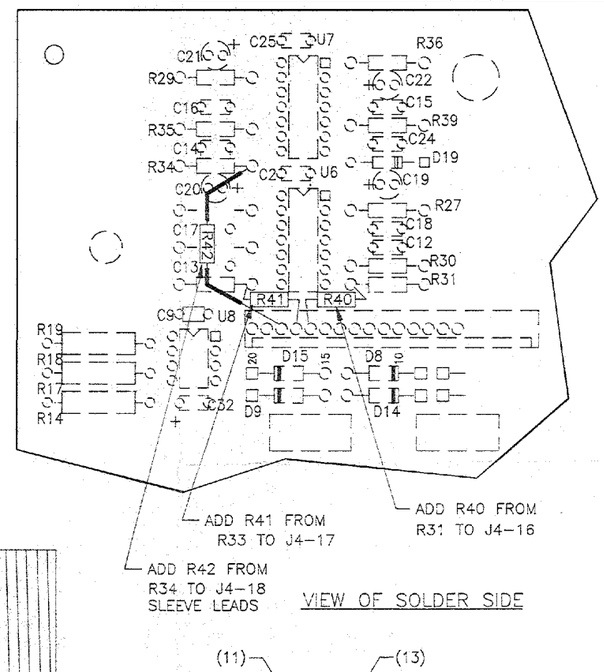
ITEM NO.	QTY REQD -102	103	-105	-106	PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
38	1	1	1	1	RN55C4752F	R8	RESISTOR, 47.5K 1/8W 1%	
39	1	1	1	1	RN55C3323F	R7	RESISTOR, 332K 1/8W 1%	
40								
41	1	1	1	1	RCR07G101JS	R27	RESISTOR,100 OHM, 1/4W 5%	
42	1	1	1	1	RCR07G301JS	R26	RESISTOR, 300 OHM, 1/4W 5%	
43	1	1	1	1	RCR07G202JS	R24	RESISTOR, 2K 1/4W 5%	
44	2	2	2	2	RCR07G332JS	R29	RESISTOR, 3.3K 1/4W 5%	
45	1	1	1	1	RCR07G472JS	R2	RESISTOR, 4.7K 1/4W 5%	
46	3	3	3	3	RCR07G103JS	R20,R21,R28,R30	RESISTOR, 10K 1/4W 5%	
47	4	4	4	4	RCR07G153JS	R3,R4,R11,R12	RESISTOR, 15K 1/4W 5%	
48	3	3	3	3	RCR07G203JS	R1,R5,R6	RESISTOR, 20K 1/4W 5%	
49	1	1	1	1	RCR07G223JS	R23	RESISTOR, 22K 1/4W 5%	
50	2	2	2	2	RCR07G303JS	R10,R22	RESISTOR, 30K 1/4W 5%	
51	1	1	1	1	RCR07G473JS	R13	RESISTOR, 47K 1/4W 5%	
52	1	1	1	1	RCR07G154JS	R14	RESISTOR, 150K 1/4W 5%	
53	3	3	3	3	RCR07G184JS	R9,R18,R19	RESISTOR, 180K 1/4W 5%	
54	1	1	1	1	RCR07G304JS	R15	RESISTOR, 300K 1/4W 5%	
55	1	1	1	1	RCR07G474JS	R17	RESISTOR, 470K 1/4W 5%	
56	1	1	1	1	RN55C1002F	R31	RESISTOR, 10K 1/8W 1%	
57	1	1	1	1	RN55C1001F	R32	RESISTOR, 1K 1/8W 1%	
58								
59								
60	1	1	1	1	3386H-1-202	R25	RESISTOR, VARIABLE, 2K	BOURNS
61	1	1	1	1	3386H-1-504	R16	RESISTOR, VARIABLE, 500K	BOURNS
62								
63	1	1	1	1	5021		EJECTOR, CARD	THERMALLOY
64	4	4	4	4	2031B	TP1-TP4	TERMINAL, TURRET, .042 DIA	USECO
65								
66	1	-	-	-		JW1	22 AWG, BUSS, SHIELDED	
67	-	-	1	1	4371-005	(D12)	RESISTOR MOUNTING STAND	BIVAR
68	-	-	A/R	A/R		JUMPER	WIRE, SOLID, 24 AWG, INSULATED	
69								
70								
71								
72								
73								
74								

BREDA COSTRUZIONI FERROVIARIE
PROGETTO / TYPE R07
MATR./ FILE 4.66.128 TAV./ SHEET 004
SEZ. ARCH./ FILE SECTION DDP
FASE PROG./ DESIGN STAGE
MODIFICATIVE / EQUALITIES

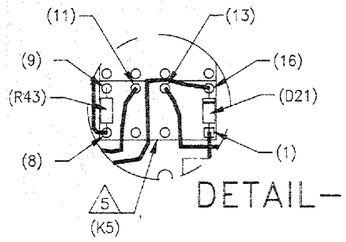
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE	2-11-93	BC
A	CREATED NEW CONFIGURATION	5-10-94	BC
B	ADDED JUMPS & CUTS; ADDED DETAIL A (EO #351151A1 & A2)	11-28-94	BC
C	ADDED R40-42; ADDED C33-35; ADDED (3) ASSOCIATED CUTS	12-7-94	RCM
D	IN "VIEW OF SOLDER SIDE," R42 (VERT) WAS R40	1-11-95	BC
E	NEXT ASSY DASH NO. WAS 103	4-3-95	KRH
F	ADDED NOTE 2 AT R1, R2, R3, R9, R10, R11, R13 PER REDLINE	12/30/96	R.YATES
G	ADDED K5 AND JUMPERS FROM K5, MOVED C23, ADDED JUMPER FROM J1-34 TO J4-5, ADDED DET.-B, ADDED R43, D21, & NOTE 5	1/3/97	R.YATES


ADD C33 ACROSS R31
CUT ETCH COMPONENT SIDE R1 TO R3
CUT ETCH SOLDER SIDE U7-5 TO U6-4
CUT ETCH COMPONENT SIDE U7-5 TO U7-10
ADD JUMPER SOLDER SIDE U7-10 TO U7-14
ADD JUMPER SOLDER SIDE U6-10 TO U6-14
ADD C35 ACCROSS R34
CUT ETCH SOLDER SIDE R34 TO J4-18
ADD C34 ACROSS R33
CUT ETCH COMPONENT SIDE R33 TO J4-17
CUT ETCH COMPONENT SIDE R31 TO J4-16
ADD JUMPER COMPONENT SIDE K5-8 TO D7
ADD JUMPER COMPONENT SIDE K5-11 TO C23-(8)
ADD JUMPER COMPONENT SIDE K5-16 TO FEED THRU HOLE (5) (BETWEEN Q1 & Q3)
ADD JUMPER COMPONENT SIDE K5-13 TO C23-(9)
ADD JUMPER COMPONENT SIDE K5-1 TO J1-34
ADD JUMPER COMPONENT SIDE THRU HOLE TO SOLDER SIDE J1-34 TO J4-5
ADD JUMPER SOLDER SIDE R11 TO R13
PWA 35-1151
SERIAL NO.
TRANSIT CONTROL SYSTEMS
COMM. CONTROL PANEL BOARD
(J4)
(R1, R2, R3)
(J1)
(R9, R10)
(J3, J5)
(T1, J2, R11, R13)





VIEW OF SOLDER SIDE



DETAIL-B

5 BOND (K5) IN PLACE WHERE SHOWN USING (ITEM 70).

4. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 35-4146.

3 RUBBER STAMP ASSEMBLY DASH NO. AND SERIAL NO. WHERE SHOWN USING .12 CHARACTERS, COLOR BLACK. COVER WITH CLEAR LACQUER.

2 DO NOT APPLY CONFORMAL COAT TO COMPONENTS INDICATED

1. CONFORMAL COAT BOTH SIDES OF CLEANED PRINTED WIRING ASSEMBLY PER MIL-STD-275 AFTER TESTING.

NOTES: UNLESS OTHERWISE SPECIFIED

DETAIL A

ORIENT TRANSISTORS AS SHOWN

SEE SEPARATE PARTS LIST

11-3.231

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
MATR./FILE 4.66.170 TAV./SHEET 001
SEZ. ARCH./FILE SECTION DDP
FASE PROG./DESIGN STAGE
EQUALIZZATE / EQUALIZED

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NOTE

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ALL 35-1145
DASH NEXT ASSY
APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMAL .X ±.1 .XX ±.03 .XXX ±.015
ANGLES ±30'
FRACTIONS ±1/16

HOLE DIAMETERS

.000/.125 +.004 -.001	.501/.750 +.008 -.001
.126/.250 +.005 -.001	.751/1.000 +.010 -.001
.251/.500 +.008 -.001	1.001/2.000 +.012 -.001

DO NOT SCALE DRAWING

DRAWN	KR HONIGMANN	DATE 1-21-93
CHECKED		
MECH ENG		
ELECT ENG		
PROD ENG		
CHIEF ENG		
CUST. APPROVAL		
CONTRACT NO.		

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE
PRINTED WIRING ASSEMBLY
COMM. CONTROL PANEL

SIZE D | CODE IDENT NO. | 35-1151 | REV. G

SCALE 2/1 | PLOT SCALE: 1/1 | SHEET 1 OF 1

REVISIONS

REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	1–25–93	BTB
A	CREATED –102 CONFIG; CHANGED QTY'S FOR ITEMS 7, 8, 10, 14, 15, 27 AND 40; DELETED ITEM 6; REPLACED ITEMS 25 & 26 WITH NEW PARTS; ADDED ITEMS 35, 37 & 45; ITEM 41 P/N WAS 7407N;	5–10–94	JM
B	ITEM 7 WAS P/N CKR05BX105KM; ITEM 12 WAS P/N CKR05BX104KR, 0.01 PF, NO MANUFACTURER.	5–24–94	BC
C	ITEM 7 QTY WAS 15; ADDED ITEM 68 (EO #35P151B1)	11–28–94	BC
D	ADDED R40–42 (ITEM 20) & C33–35 (ITEM 12). CREATED –103 CONFIG	12–7–94	BC
E	CREATED –104 CONFIG. ADDED ITEM 47. R21 WAS ITEM 34.	4–3–95	KRH
F	CREATED –105 CONFIG., ADDED ITEMS 5, 17, 69, 70, (ADDED R43 & D21 FOR –105), REMOVED –102 & –103	1–3–97	R.YATES
G	ITEM 56 WAS P/N 593002	1–28–97	R.YATES
H	ADDED ITEM 34	4–10–97	ALS

BREDA COSTRUZIONI FERROVIARIE	
PROGETTO / TYPE	R07
MATR. / FILE	4.66.170
TAV. / SHEET	002
SEZ. ARCH. / FILE SECTION	DDP
FASE PROG. / DESIGN STAGE	
EQUIPAGGIAMENTI / EQUALITES	

11-3.233

NOTES: UNLESS OTHERWISE SPECIFIED

		DRAWN: KR HONIGMANN	DATE: 1–14–93
		CHECKED:	
		ENGINEER:	
105	35–1145		
104	35–1145		
DASH	NEXT ASSY	CHIEF ENG:	
APPLICATION			

TRANSIT CONTROL SYSTEMS

TITLE: COMMUNICATIONS CONTROL PANEL PWA PARTS LIST

SIZE	CODE IDENT NO.	PART LIST NO.	REV.
A		PL–35–1151	H
SCALE: NONE			SHEET 1 OF 3

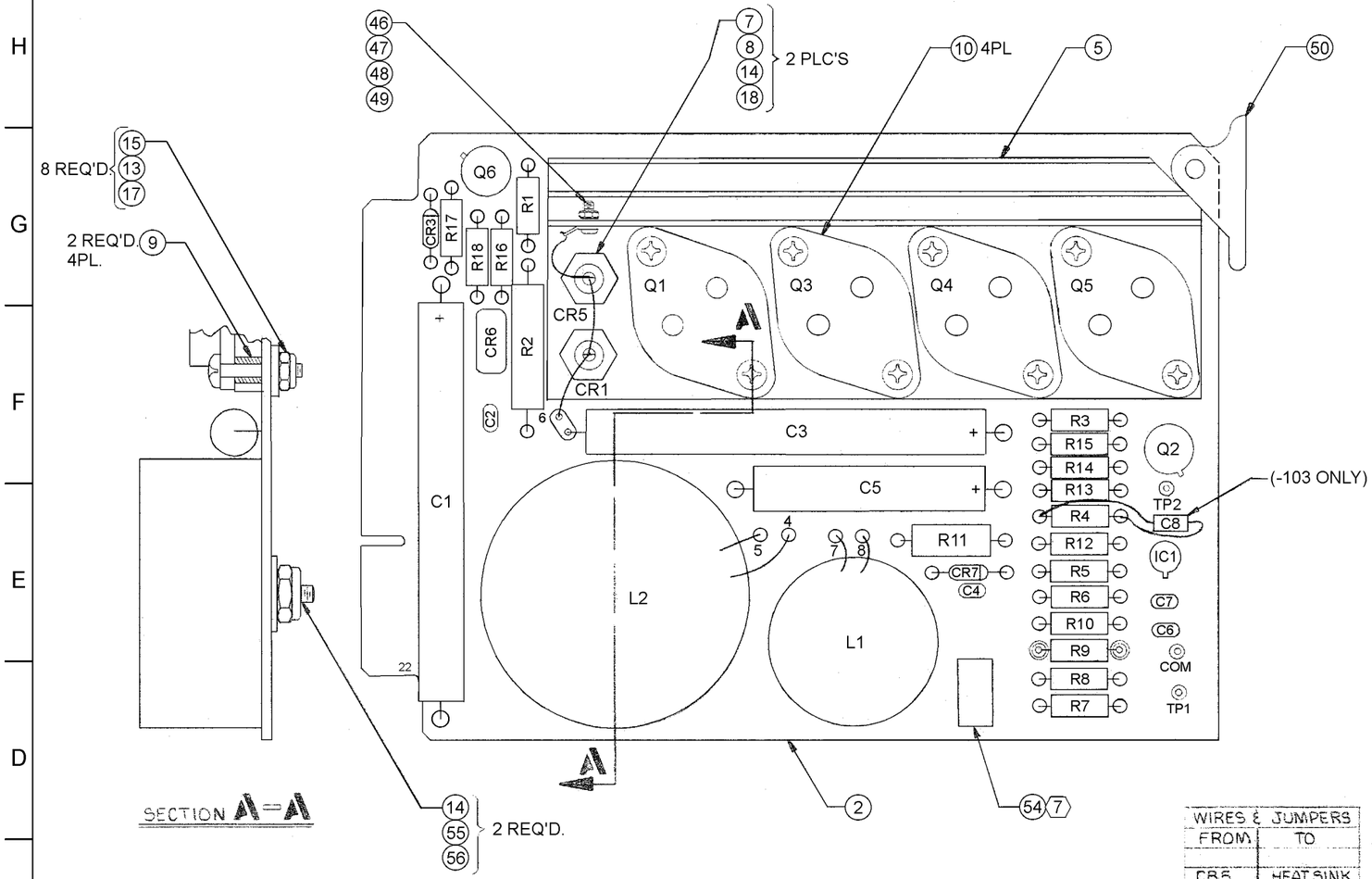
TRANSIT CONTROL SYSTEMS	TITLE: COMMUNICATIONS CONTROL PANEL PWA PARTS LIST	PARTS LIST NO. PL35-1151	REV. H	ADVANCE ___ RELEASE _X_

ITEM NO.	QTY REQD -104	QTY REQD -105		PART NO.	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
1	1	1		35-2152-2		PWB, COMM. CONTROL PANEL	TCS
2	REF	REF		35-4146		SCHEMATIC, COMM. CONTROL PANEL	TCS
3	REF	REF		35-7150		ATP, COMM. CONTROL PANEL	TCS
4							
5	–	1		437150	R3	RESISTOR, 150, 3W, 1%	OMITE
6							
7	14	14		CKR05BX104KM	C2, 11-14, 23, 25-32	CAPACITOR, CERAMIC, 0.1 uf, 50V, 20%	KEMET
8	4	4		515D107M050BB6A	C1,3,6,7	CAPACITOR, 100 uf, 50V	SPRAGUE
9	1	1		515D105M100JA6A	C5	CAPACITOR, 1 uf, 100V	SPRAGUE
10	6	6		515D106M050JA6A	C8,10,19-22	CAPACITOR, 10 uf, 50V	SPRAGUE
11	1	1		C317C330M2G5CA	C9	CAPACITOR, CERAMIC, 33 PF, 200V	KEMET
12	7	7		CKR05BX103KR	C15-18, 33-35	CAPACITOR, CERAMIC, 0.01 uF, 50V	KEMET
13							
14	16	17		1N4007	D1-10, 12-16, 18, 21	DIODE (D21 (-105 ONLY))	
15	3	3		1N4148	D11, 19, 20	DIODE	
16	1	1		1N4746A	D17	DIODE, ZENER	
17	–	3		43F270	R1, 2, 11	RESISTOR, 270, 3W, 1%	OHMITE
18	1	1		AZ830-4C-24DEA	K1	RELAY, MINATURE, 4PDT, 24VDC	AMER. ZETTLER
19	3	3		AZ830-2C-5DSE	K2-4	RELAY, MINATURE, DPDT, 5VDC	AMER. ZETTLER
20	3	3		RN60C1100F	R40-42	RESISTOR, 110, 1/4W, 1%	
21	4	–		43F270	R1-3, 11	RESISTOR, 270, 3W, 1%	OHMITE
22	1	1		43J4R0	R9	RESISTOR, 4, 3W, 5%	OHMITE
23	1	1		43JR20	R10	RESISTOR, 0.2, 3W, 5%	OHMITE
24	1	1		43J750	R13	RESISTOR, 750, 3W, 5%	OHMITE
25	1	1		RN60C6192F	R36	RESISTOR, 61.9K, 1/4W, 1%	
26	3	3		RN60C6191F	R27-29	RESISTOR, 6.19K, 1/4W, 1%	
27	2	2		RCR07G473JS	R8, 37	RESISTOR, 47K, 1/4W, 5%	
28	1	1		RN60C1500F	R12	RESISTOR, 150, 1/4W, 1%	
29	2	2		RN60C1502F	R15,21	RESISTOR, 15.0K, 1/4W, 1%	
30	2	2		RN60C1002F	R14,16	RESISTOR, 10.0K, 1/4W, 1%	
31	2	2		RN60C4750F	R17,22	RESISTOR, 475, 1/4W, 1%	
32	1	1		RN60C1822F	R18	RESISTOR, 18.2K, 1/4W, 1%	
33	2	2		RN60C1001F	R19,20	RESISTOR, 1.0K, 1/4W, 1%	
34		1		AZ820-2C-24DE	K5	RELAY	AMER. ZETTLER
35	12	13		RCR07G472JS	R23-26,30-35,38,39,43	RESISTOR, 4 (R43 (-105 ONLY))	
36	1	1		MC7805CT	VR1	VOLTAGE REGULATOR	
37	3	3		MPF6661	Q1-3	TRANSISTOR	

BREDA COSTRUZIONI FERROVIARIE
PROGETTO / TYPE R07
MATR. / FILE 4.66.170 TAV. / SHEET 903
SEZ. ARCH. / FILE SECTION DDP
FASE PROG. / DESIGN STAGE
UGUALE A / EQUALITES

TRANSIT CONTROL SYSTEMS				TITLE: COMMUNITIONS CONTROL PANEL PWA PARTS LIST		PARTS LIST NO. PL35–1151	REV. H	ADVANCE ___ RELEASE _X_ SHEET 3 OF 3
ITEM NO.	QTY REQD –104	QTY REQD –105		PART NO.	REFERENCE DESIGNATOR	DESCRIPTION		MANUFACTURER
38	1	1		120–6103–001	T1	TRANSFORMER		TCS
39								
40	1	1		74LS04N	U5	I.C., HEX INVERTER		
41	1	1		74LS32N	U1	I.C., HEX DRIVER		
42	1	1		74LS27N	U4	I.C., 3 INPUT NOR GATE		
43	2	2		74LS74AN	U2,3	I.C., FLIP–FLOP		
44								
45	2	2		LM556N	U6,7	I.C., DUAL OP AMP		
46	3	3		2031B	TP1–3	TEST POINT, TURRET		USECO
47	1	1		TL082BCP	U8	I.C., OP AMP		
48	1	1		206934–1	J1	RECEPTACLE, 37 PIN, SQ FLANGE,		AMP
49	1	1		22–23–2031	J2	HEADER, 3 PIN		MOLEX
50	1	1		22–23–2091	J3	HEADER, 9 PIN		MOLEX
51	1	1		22–23–2201	J4	HEADER, 20 PIN		MOLEX
52	1	1		22–23–2041	J5	HEADER, 4 PIN		MOLEX
53								
54	4	4		BR6910B–0.875–44		STANDOFF, SWAGE, 1/4 ROUND		LYN–TRON
55								
56	1	1		593002B03400	XVR1	HEATSINK		AAVID
57								
58	1	1		7403–09FR–58		INSULATOR, TO220		BERGQUIST
59								
60	1	1		MS51957–16		SCREW, PAN HD, #4–40 X 7/16" LG		
61								
62	2	2		MS15795–804		WASHER, FLAT, #4		
63								
64	1	1		MS35338–154		WASHER, LOCK, #4		
65								
66	1	1		MS35649–244		NUT, HEX, #4–40		
67								
68	A/R	A/R				BUSS WIRE, SOLID, 22 AWG		
69	–	A/R				INSULATED WIRE, SOLID, 24 AWG		
70	–	A/R		444		TAK–PAK		
71								
72								
73								
74								

BREDA COSTRUZIONI FERROVIARIE
PROGETTO / TYPE R07
MATR. / FILE 4,66.170 TAV. / SHEET 004
SEZ. ARCH. / FILE SECTION DDP
FASE PROG. / DESIGN STAGE
UGUAGLIANZE / EQUALITIES



WIRES & JUMPERS	
FROM	TO
CR5	HEATSINK
L2-1	4
L2-2	5
CR1	6
CR1	CR5
L1-1	7
L1-2	8
(-103 ONLY) L2-4	L2-5

(DELETE -103 ONLY)

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	F	REDRAWN (REPLACED), INC E.O.'S A02240 AND A02242	2/8/89	
	G	INCORP. EO's A02419 & A02483	11/23/92	
	H	ADDED CONTRACT NO.	1-8-93	BJ
	J	ADDED ITEM 54 & NOTE 7.	8/10/93	BJ
	K	REVISED PER E.O. B51018J1	8/22/96	KF

BREDA COSTRUZIONI FERROVIARIE
PROGETTO/TYPE R07
DATA/FILE 4.66.171 FOGLIO/SHEET 001
SEZ. ABIL./FILE SECTION DDP
FASE PROG./DESIGN STAGE
UGUAGLIANZE / EQUALITIES

DASH 103	DASH 102	DASH 101	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
				QTY REQD PER ASSY	PARTS LIST / LIST OF MATERIAL		
3	3	3	42	LM295K	TRANS/I.C	NATIONAL	Q3 Q4 Q5
2	2	2	41	2N5339	TRANSISTOR		Q2,Q6
1	1	1	40	2N5039	TRANSISTOR		Q1
1	1	1	39	RC20GF123J	RESISTOR, 12K ½W		R8
1	1	1	38	RC20GF473J	RESISTOR, 47K ½W		R7
1	1	1	37	RC20GFXXXJ	RESISTOR, APPROX 2.2K ½W		R9, TEST SELECT
1	1	1	36	RC20GF472J	RESISTOR, 4.7K ½W		R10
1	1	1	35	RC32GF821J	RESISTOR, 820Ω 1W		R11
3	3	3	34	RC20GF103J	RESISTOR, 10K ½W		R3,R5,R16
1	1	1	33	RC20GF102J	RESISTOR, 1K ½W		R4
1	1	1	32	RC20GF105J	RESISTOR, 1M ½W		R6
1	1	1	31	95J5R0	RESISTOR, 5Ω 5W	OHMITE	R2
2	2	2	30	RC20GF202J	RESISTOR, 2K ½W		R1,R17
1	1	1	29	RC07GF512J	RESISTOR, 5.1K ¼W		R12
4	4	4	28	C330C104M1R5CA	CAPACITOR, .1uf	KEMET	C2,C4,C6,C7
1	1	1	27	600D476F075DG4	CAPACITOR, 47uf	SPRAGUE	C5
2	2	2	26	600D167G060DX5	CAPACITOR, 160uf	SPRAGUE	C1,C3
1	1	1	25	1N4757	DIODE		CR3
1	1	1	24	1N4742	DIODE		CR7
1	1	1	23	1N3890	DIODE		CR5
1	1	1	22	1N3673A	DIODE		CR1
3	3	3	21	RC20GF512J	RESISTOR, 5.1K ½W		R13,R14,R15
1	1	1	20	RC20GF471J	RESISTOR, 470Ω ½W		R18
1	1	1	19	V56ZA8	VARISTOR	G.E.	CR6
2	4	4	18	22-NTM-02	NUT, HEX, LOCK		#10, or 79-NTM-02
8	8	8	17	22-NM-40	NUT	ESNA	#4
2	2	2	16	2031B	TERMINAL TURRET	USECO	R9 .044Ø +.003 -.001, TOOL # 2071
8	8	8	15	MS15795-803	WASHER, FLAT		#4
3	4	4	14	MS15795-808	WASHER, FLAT		#10
8	8	8	13	MS51957-17	SCREW, PAN HD		4-40 X 7/16
3	3	3	12	2030B	TERMINAL TURRET	USECO	TP1,2,COM, .064Ø +.003 -.001, TOOL # 2030
1	1	1	11	40-2074-06	HEATSINK		
4	4	4	10	DM101	INSULATOR	DELBERT BLINN	
8	8	8	9	TW140-180-170-T	SPACER		
2	2	2	8	TW195-245-125N	SPACER		
2	2	2	7	MW425-197	INSULATOR	DELBERT BLINN	
—	—	—	6	-102	ASSEMBLY		
—	—	1	5	40-2074-01	HEATSINK		
1	1	1	4	40-2075-01	INDUCTOR		L1
—	—	1	3	40-2076-01	INDUCTOR		L2
1	1	1	2	35-2017-01	P.C. BOARD		
—	—	—	1	-101	ASSEMBLY		

DASH 103	DASH 102	DASH 101	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
				QTY REQD PER ASSY	PARTS LIST / LIST OF MATERIAL		
2	2	2	56	MS35650-304	NUT		10-32
2	2	2	55	MS35338-137	WASHER, SPLIT LOCK		#10
-	1	-	54	10-9051	BAR CODE LABEL	TCS	
1	-	-	53	CK06BX474K	CAPACITOR .47uf		C8
1	-	-	52	RC20GF182J	RESISTOR 1.8K, ½W		R4
	-	-	51	-103	ASSEMBLY		
1	1	-	50	5203	EJECTOR, WHITE	SCANBE	
1	1	1	49	1415-6	LUG		#6
1	1	1	48	MS35333-71	WASHER, LOCK		#6
1	1	1	47	MS35649-264	NUT		#6
1	1	1	46	MS51957-27	SCREW PAN HD		6-32 X 5/16
REF	REF	REF	45	35-4008	SCHEMATIC		
A/R	A/R	A/R	44		WIRE, INSULATED		20AWG
1	1	1	43	LM119H	INTEGRATED CKT	NATIONAL	IC1

DASH 103	DASH 102	DASH 101	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
				QTY REQD PER ASSY	PARTS LIST / LIST OF MATERIAL		

⟨7⟩ APPLY BAR CODE LABEL APPROX WHERE SHOWN.

6. -102 ASSY EFFECT SERIAL NO'S FROM 712 TO 725 & FROM 728 TO 746 (26 UNITS)

5. MODIFY P.C. BOARD AS FOLLOWS, USING JUMPER OF 20 GAUGE BUS WIRE: ON SOLDER SIDE ADD JUMPER FROM L2-4 TO L2-5 FOR (-102 ASSY ONLY).

4. CONFORMAL COAT .0003-.0007 THK. EXCEPT ITEM 5, R2, CR1, CR5, Q1, Q3, Q4, Q5 & FINGERS

3. TEST, PER TEST PROCEDURE 35-7022

2. HEAT SINK COMPOND, DOW # 340 TO BE INSTALLED BETWEEN Q1, Q3-Q5 AND HEATSINK

1. RUBBER STAMP ASSY NO. & SERIAL NO., WHERE PROVIDED.

NOTES: UNLESS OTHERWISE SPECIFIED.

DASH	NEXT ASSY
101	10-1045
103	35-1078
102	10-1088
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
.X DECIMAL ±
.XX DECIMAL ±
.XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

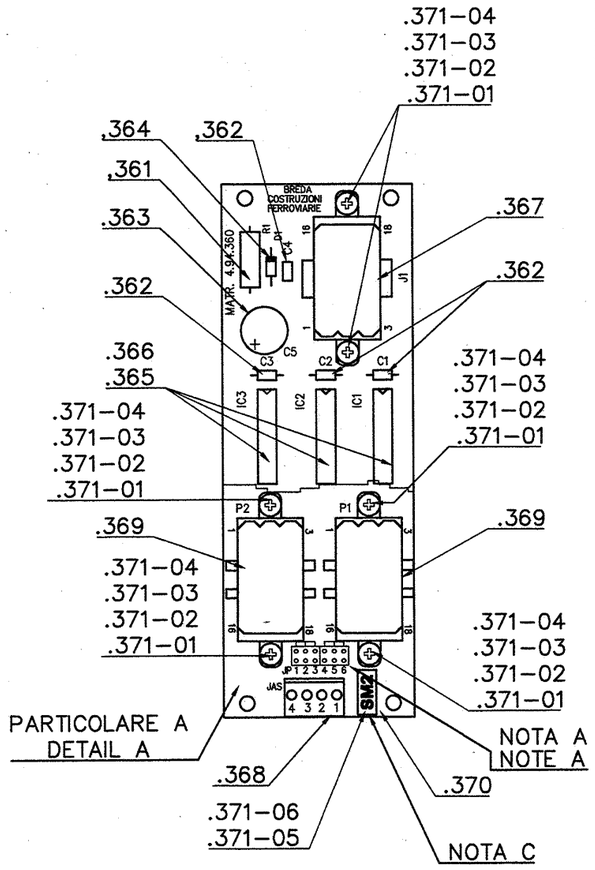
DRAWN Gentile V 2-7-88 K. KELLY
CHECKED LOREN
APPROVAL
APPROVAL

11-3.239

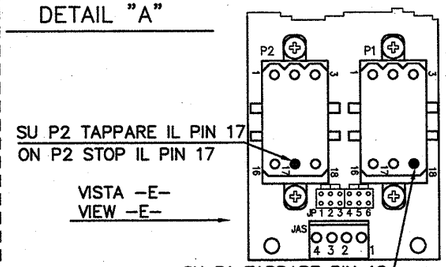
TRANSIT CONTROL SYSTEMS

TITLE
ASSEMBLY - 28V
DC-TO-DC CONVERTER

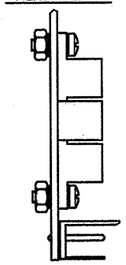
SIZE D | CODE IDENT NO. | 35-1018 | REV. K
SCALE 2:1 | SHEET 1 OF 1



PARTICOLARE "A"
DETAIL "A"



VISTA –E–
VIEW –E–



NOTA B:

PER TAPPARE 1 PIN CONTRASSEGNATI DEI CONNETTORI POSTI SUL C. S. PROCEDERE NEL SEGUENTE MODO :

1) – TAGLIARE LA PARTE DI CONTATTO MASCHIO DEL TIPO 14.266.0 (WEIDMULLER).IL CONTATTO TAGLIATO DEVE AVERE UNA LUNGHEZZA DI CIRCA 5mm.

2) – APPLICARE SUL CONTATTO UN LEGGERO STRATO DI COLLA (LOCTITE O SIMILARE).

3) – INSERIRE IL CONTATTO NELLO SPECIFICO PIN DA TAPPARE

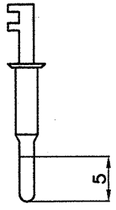
NOTE B:

TO STOP THE MARKED PIN PLACED ON THE C.S. PROCEED IN THE FOLLOWING WAY

1) – CUT THE SIDE OF A MALE CONTACT TYPE 14.266.0 (WEIDMULLER).THE CONTACT CUTTED MUST BE LONG 5 mm. ABOUT

2) – APPLY ON THE CONTACT A LITTLE COAT OF GLUE (LOCTITE OR SIMILAR).

3) – PUT THE CONTACT IN THE SPECIFIC PIN



NOTA A:

PONTICELLARE TRA LORO I PUNTI 1 – 2 – 3 DI JP
PER COLLEGARE GLI SCHERMI DEL PRIMO GRUPPO DI SCHERMATI
PONTICELLARE TRA LORO I PUNTI 4 – 5 – 6 DI JP
PER COLLEGARE GLI SCHERMI DEL SECONDO GRUPPO DI SCHERMATI
I PONTICELLI DEVONO ESSERE FATTI SULLE SCHEDE DENOMINATE SM2

JUMPER POINT 1 – 2 – 3 OF JP FOR CONNECTING FIRST GROUP OF SHIELD
JUMPER POINT 4 – 5 – 6 OF JP FOR CONNECTING SECOND GROUP OF SHIELD
THE JUMPER AS BEEN MADE ON THE NAME P.C.B. SM2

NOTA C:

IDENTIFICARE CON LA TARGHETTA "SM1" MATR. 4.94.371 – 05 IL C.S. SENZA PONTICELLI.
IDENTIFICARE CON LA TARGHETTA "SM2" MATR. 4.94.371 – 06 IL C.S. CON I PONTICELLI

IDENTIFY WITH THE LABEL "SM1" MATR. 4.94.371 – 05 IL C.S. WITHOUT JUMPER
IDENTIFY WITH THE LABEL "SM2" MATR. 4.94.371 – 06 IL C.S. WITH THE JUMPER

NOTE @:

DISEGNO VALIDO FINO AL 77° VEIVOLO COMPRESO
DRAWING VALID UNTIL THR 77 TH VEHICLE INCLUDED

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. UNITARY WEIGHT	Lbs. UNITARY WEIGHT
06		1	TARGHETTA – "SM2" LABEL – "SM2"	9.89.940/.944			
05		1	TARGHETTA – "SM1" LABEL – "SM1"	9.89.940/.943			
04		6	DADO NUT	SIZE 4 STC – 542	TYPE N STC – 542	.003	.006
03		6	RONDELLA GROVER SPRING WASHER	SIZE 4 STC –515	TYPE N STC – 515	.001	.002
02		12	RONDELLA PIANA FLAT WASHER	SIZE 4 STC – 514	TYPE N STC – 514	.001	.002
01		6	VITE T.C. PAN.HE.MAC.SC	SIZE 4 x 1/2 STC – 510	TYPE N STC – 510	.002	.004
.371							
.370		1	CIRCUITO STAMPATO P.C.B.	4.94.374		.090	.198
.369		2	CONNETTORE FEMMINA 18 PIN FEMALE 18 PINS CONNECTOR	WEIDMULLER	Cat. 14447.0	.030	.066
.368		1	CONNETTORE 4 POLI VERT. 4 PINS VERT. CONNECTOR	AMP	TIPO AMPMODU I Cat. 280610–2	.008	.016
.367		1	CONNETTORE MCH DA 18 PIN 18 PINS MALE CONNECTOR	WEIDMULLER	Cat. 14449.0	.030	.060
.366		3	ZOCCOLO TULIPANO SOCKET TULIP	DISTRELEC (PD PRECI DIP)	Art. 65 06 05 o Sim.	.005	.010
.365		3	CIRCUITO INTEGRATO I.C.	MAXIM	Art. MAX 333 AEPP		
.364		1	DIODO ZENER 15V 2W ZENER DIODE 15V 2W	ITT	1N4744A o Sim.		
.363		1	CONDENSATORE 470mF 63V 5% CAPACITOR 470mF 63V 5%	SIEMENS	TIPO X7R/25U/2E3 o Sim.		
.362		4	CONDENSATORE CERAMICO CERAMIC CAPACITOR 100nF 63V	SIEMENS	TYPE X7R/Z5U/2E3 o Sim.		
.361		1	RESISTENZA 1kohm 1W 5% RESISTOR 1Kohm 1W 5%	DISTRELEC (ARCNHEOM)	ART 71 23 48 o Sim.		

DISEGNO ESEGUITO CON CAD - SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT - ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE: IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGULARI VEDI TAB. UNI ISO 2768.
TOLERANCES: UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
3	03/03/2000	CABEL	NUONNO	ING. C.A.DAMI	SPECIFICATION MOUNTING CONNECTOR P.C.B.
2	30/12/98	BINDI	FERRARI	BANDINELLI	ADDED NOTE @ CFG 3006
1	04/09/95	CABEL	A.B.	BANDINELLI	ADDE
0	11/11/94	CABEL	A.B.	BALDI	ISSUE

11-3.241

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE 1 : 1
QUANTITA' / QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK
UGUAGLIANZE / EQUALITES
PESO UNITARIO / UNITARY WEIGHT: Kg. Lbs.
SOSTITUISCE IL SUPERSEDED
FOGLIO / SHEET 1 DI / OF 1

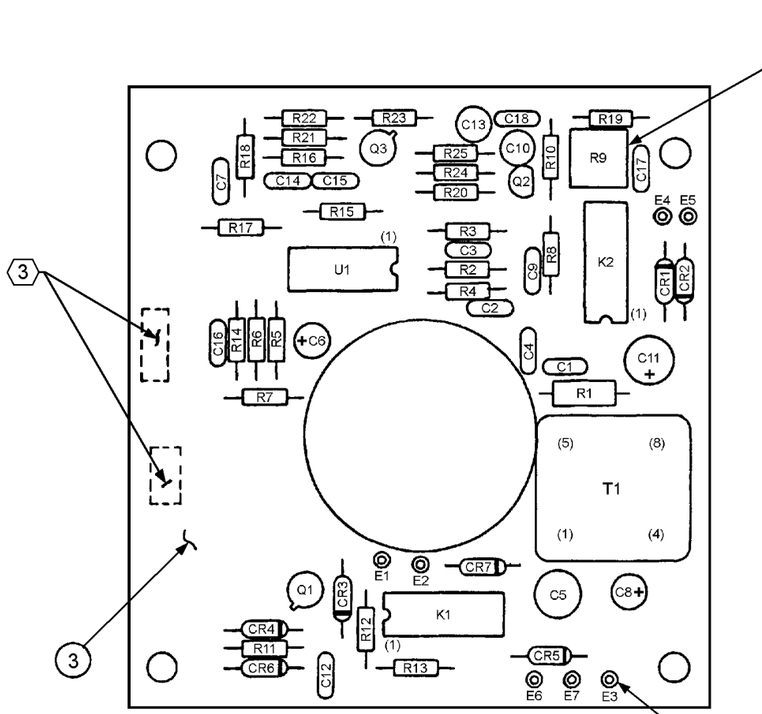
DESCRIZIONE / DESCRIPTION: LRV S. FRANCISCO
COMPLESSIVO C.S.
P.C.B. LAYOUT

BREDA COSTRUZIONI FERROVIARIE — GRUPPO EFIM

COMMESSA / JOB: 111B
CONTRACT N.: #309

TIPO / TYPE: R07
MATR. / FILE: 4.94.360
DISEGNO / DWG. N.: 150038

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		RELEASED	1/17/85	
	A	C13 WAS C12, ADDED CR7	4/4/85	
	B	RELOCATED C9	4/23/85	



4 CONFORMAL COAT .0003 - .0007 THICK. COAT ENTIRE BOARD EXCEPT R9, E1 THRU E7.

3 RUBBER STAMP ASSEMBLY DASH NO. & SERIAL NO. (CIRCUIT SIDE)

2. ACCEPTANCE TEST AT NEXT ASSEMBLY LEVEL.

1. SCHEMATIC DIAGRAM 10 - 4307

NOTES: UNLESS OTHERWISE SPECIFIED.

SEE SEPARATE PARTS LIST

11-3.243

DASH	DASH	DASH	DASH	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MANUFACTURER	DATA
QTY REQD PER ASSY					PARTS LIST / LIST OF MATERIAL			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
X DECIMAL ±
XX DECIMAL ±
XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

DRAWN ERNIE V 1/10/85
CHECKED G.H.B
APPROVAL 1/10/85
APPROVAL 1/10/85
APPROVAL
CUST. APPROVAL
CONTRACT NO.

10-1305-101
DASH NEXT ASSY
APPLICATION

TRANSIT CONTROL SYSTEMS

TITLE ASSEMBLY-
PASSENGER INTERCOM P.C.B

SIZE D | CODE IDENT NO. | 10-1310 | REV. B

SCALE 2:1 | SHEET 1 OF 1

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PARTS LIST	TITLE ASSEMBLY, PASSENGER INTERCOM PCB	FSCM NO.	DWG. NO. PL10-1310	REV. B
			SHEET 3 OF 5	

ITEM NO.	QTY REQD -101		PART NO.	DESCRIPTION	DATA
1			-101	ASSEMBLY	
2					
3	1		10-2311-2	PCB	
4					
5	2		118-2424-005	RELAY,HIGH SENSITIVITY MINIATURE,2'C'	K1,2
6					
7	4		IN4007	DIODE	CR1,3,5,7
8	1		IN5226B	DIODE	CR4
9	1		IN5231A	DIODE	CR6
10	1		IN4736A	DIODE	CR2
11					
12	1		2N2222A	TRANSISTOR	Q1
13	1		2N3906	TRANSISTOR	Q2
14	1		120-6110-101	TRANSISTOR, FIELD EFFECT	Q3
15	1		109-5753-402	IC, OP AMP, QUAD	U1
16					
17	1		120-6103-001	TRANSFORMER, AUDIO	T1
18					
19	1		118-2701-013	RESISTOR, VARIABLE, PC MOUNT	R9
20					

SOURCE

A	B
PART NUMBER / MANUFACTURER	
DS2EMDC24 AROMAT	
VCR4N SILICONIX	VCR4N INTERSIL
LM224N MOTOROLA	CA224E RCA
TCS	PC-0-30 OPT INDUSTRIES/UTC
3386F-1-503 BOURNES	72PM-50K BECKMAN

11-3.245

PARTS LIST	TITLE ASSEMBLY, PASSENGER INTERCOM PCB	FSCM NO.	DWG. NO. PL10-1310	REV. E
			SHEET 4 OF 5	

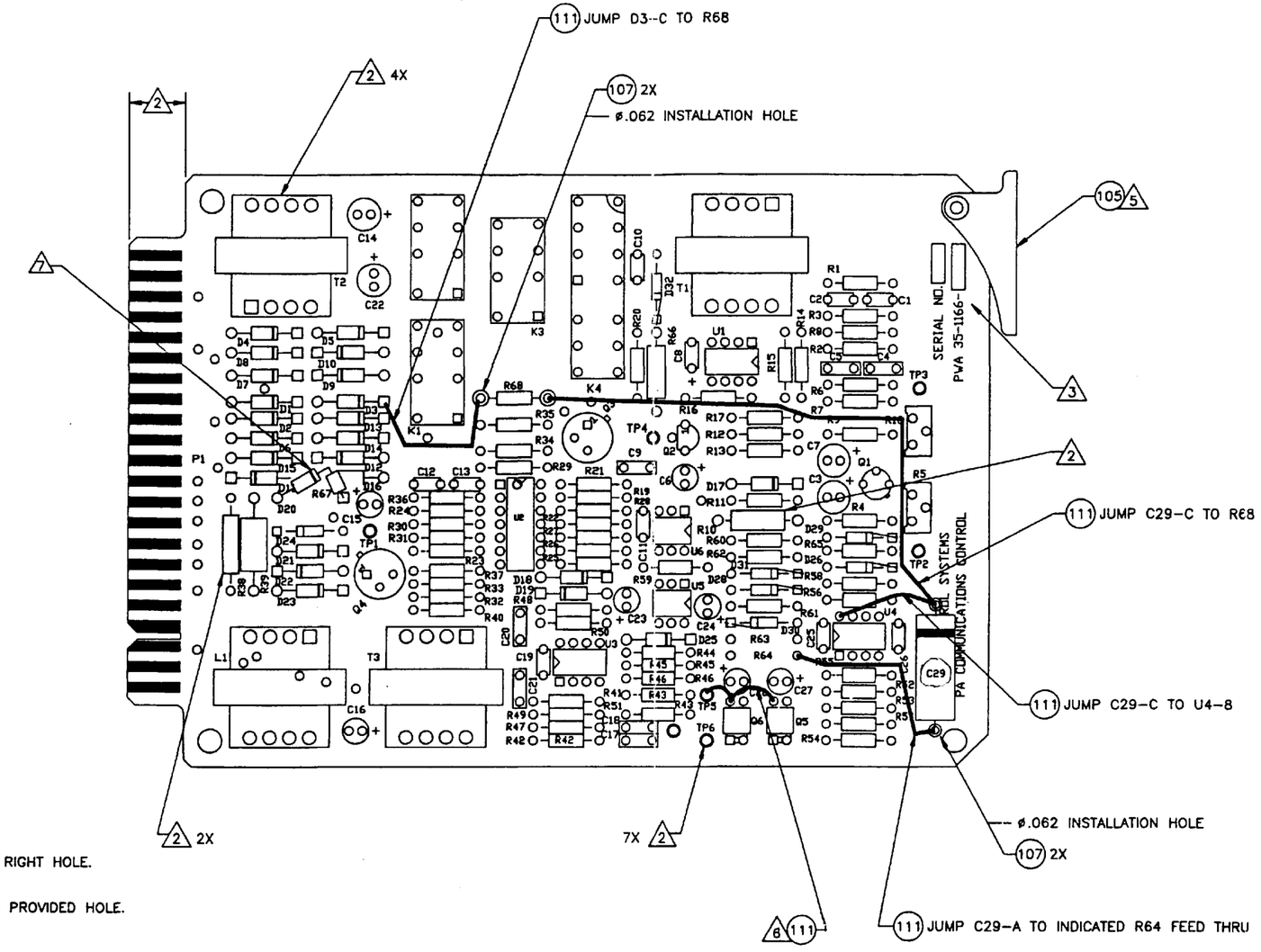
ITEM NO.	QTY REQD -101		PART NO.	DESCRIPTION	DATA	SOURCE A: PART NUMBER / MANUFACTURER	SOURCE B
21	2		RCR07G103JS	RESISTOR, 10K	R5,11		
22	1		202	2K	R12		
23	4		102	1K, 1/4W	R4,14,15,18		
24	1		470	47 OHM	R19		
25	2		273	27K	R6,16		
26	1		RCR07G203JS	20K	R7		
27	1		RN55C5902F	59K	R17		
28	1		RCR07G473JS	47K	R22		
29	2		472	4.7K	R21,8		
30	1		622	6.2K	R23		
31	2		434	430K	R20,25		
32	1		684	680K	R24		
33	1		RCR07G822JS	8.2K	R10		
34	1		RN55C2493F	249K	R3		
35	1		RCR07G123JS	12K	R2		
36	1		RCR20G102JS	1K, 1/2W	R1		
37	1		RCR07G622JS	RESISTOR, 6.2K	R13		
38	4		103-1602-116	CAPACITOR, CER RAD 1.0	C1,12,18,4	CKR06BX105KR or S MIL TYPE	MIL-C-39014/2-1415 or 1419 MIL SPEC
39	2		515D476M063B6A	CAPACITOR, ALU. ELEC. RAD, 47, 63V	C5,11	SPRAGUE	
40	2		515D106M100AAGA	CAPACITOR, ALU. ELEC. RAD, 10, 100V	C6,8	SPRAGUE	

11-3.247

PARTS LIST	TITLE: ASSEMBLY, PASSENGER INTERCOM PCB	FSCM NO.	DWG. NO. PL10-1310	REV. E 1
			SHEET 5 OF 5	

ITEM NO.	QTY REQD -101		PART NO.	DESCRIPTION	DATA	SOURCE A: PART NUMBER / MANUFACTURER	SOURCE B
41	2		685RSS050M	CAPACITOR, ALU. ELEC. RAD, 6.8, 50V	C13,10	ILLINOIS CAPACITOR	
42	2		103-1602-067	CER. RAD, .047	C14,7	CKR05BX473KR or S MIL TYPE	MIL-C-39014/1-1547 or 1587 MII SPEC
43	1		103-1602-055	CER. RAD, .01	C17	CKR05BX103KR or S MIL TYPE	MIL-C-39014/1-1535 or 1575 MII SPEC
44	3		103-1602-073	CER. RAD, .1	C15,16,9	CKR05BX104KR or S MIL TYPE	MIL-C-39014/1-1553 or 1593 MII SPEC
45	2		103-1602-013	CAPACITOR, CER. RAD, 47PF	C2,3	CKR05BX470KR or S MIL TYPE	MIL-C-39014/1-1293 or 1333 MII SPEC
46							
47	7		120-2620-001	TURRET, P.C. MOUNT	E1-E7	2031B USECO	
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE	2-11-93	BC
A	ADDED JUMPERS.	12-6-93	BC
B	CREATED -102 CONFIG	9-29-94	BC
C	CREATED -103 CONFIG (EO #351166B1)	1-10-95	BC
D	ITEM 107 INSTALLATION HOLE WAS ø.094	3-24-95	KRH



7 INSTALL D20 INTO LEFT HOLE, R67 INT RIGHT HOLE. SOLDER THEM TOGETHER AS SHOWN.

6 DO NOT INSTALL Q5-S AND Q6-S INTO PROVIDED HOLE. JUMP Q5-S TO Q6-S TO TP5.

5 INSTALL AFTER CONFORMAL COATING.

4. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 35-4167.

3 RUBBER STAMP ASSEMBLY DASH NO. AND SERIAL NO. WHERE SHOWN USING .12 CHARACTERS, COLOR BLACK. COVER WITH CLEAR LACQUER.

2 DO NOT APPLY CONFORMAL COAT TO COMPONENTS INDICATED.

1. CONFORMAL COAT BOTH SIDES OF CLEANED PRINTED WIRING ASSEMBLY PER MIL-STD-275 AFTER TESTING.

NOTES: UNLESS OTHERWISE SPECIFIED

SEE SEPARATE PARTS LIST

11-3.251

PROPRIETARY NOTICE
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NOTE
THIS DRAWING IS COMPUTER GENERATED. ALL CHANGES SHALL BE CONTROLLED VIA THE MASTER DISK FILE.

103	35-1160
DASH	NEXT ASSY
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:
DECIMAL .X ±.1 .XX ±.03 .XXX ±.015
ANGLES ±30'
FRACTIONS ±1/16
HOLE DIAMETERS
.093/.125 +.004 -.001 .501/.756 +.008 -.001
.126/.250 +.005 -.001 .751/1.000 +.010 -.001
.251/.500 +.008 -.001 1.001/2.000 +.012 -.001
DO NOT SCALE DRAWING

DRAWN	HITCHCOCK,J	1-21-93
CHECKED	B.C.	2-11-93
MECH ENG		
ELECT ENG	B.T. BLEACHER	2-11-93
PROG ENG		
CHIEF ENG	JOHN G. KIEL	
CUST APPROVAL		
CONTRACT NO.		

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE
PRINTED WIRING ASSEMBLY
PA COMM CONTROL BD

SIZE	CODE IDENT NO.		REV.
D		35-1166	D

SCALE 2/1 PLOT SCALE: 1/1 SHEET 1 OF 1

TRANSIT CONTROL SYSTEMS	TITLE: PA COMMUNICATIONS CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1166	REV. H	ADVANCE ____ RELEASE _X_
				SHEET 2 OF 4

ITEM NO.	QTY REQD -104			PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
1							
2	1			35-2168-2		PWB, PA COMM CONTROL BOARD	
3	REF			35-4167		SCH, PA COMM CONTROL BOARD	
4							
5							
6							
7							
8							
9							
10	1			LM741CN	U1	IC, LINEAR	NATIONAL
11	1			LM2900N	U2	IC, LINEAR	NATIONAL
12	2			LM258N	U3, U4	IC, LINEAR	NATIONAL
13	2			4N33	U5, U6	IC, OPTICAL ISOLATOR	MOTOROLA
14							
15	1			AZ830-2C-24DE	K3	RELAY, MINIATURE 24V DPDT 2'C'	AMER. ZETTLER
16	1			AZ830-4C-12DSEA	K4	RELAY, MINIATURE 12V 4PDT 4'C', SENSI	AMER. ZETTLER
17	2			AZ830-2C-24DSE	K1, K2	RELAY, MINIATURE 24V DPDT 2'C', SENSI	AMER. ZETTLER
18							
19	3			120-6103-001	T1,T2,T3	TRANSFORMER, AUDIO	TCS
20	1			PC-0-36	L1	INDUCTOR, AUDIO	UTC/OPT
21							
22							
23	1			2N3906	Q2	TRANSISTOR	
24	1			2N4235	Q4	TRANSISTOR	
25	1			2N4238	Q3	TRANSISTOR	
26	2			IRFD120	Q6,Q5	TRANSISTOR, FIELD EFFECT	INTER. RECT.
27	1			VCR2N	Q1	TRANSISTOR, FIELD EFFECT	SILICONIX
28							
29	1			1N5245B	D32	DIODE, ZENER	
30	23			1N4007	D1-16,18-21,23,25, 27	DIODE	
31	1			1N4730A	D22	DIODE, ZENER	
32	1			1N4736A	D17	DIODE, ZENER	
33	2			1N5221B	D30,D31	DIODE, ZENER	
34	2			1N5231B	D28,D29	DIODE, ZENER	
35							
36	1			1N5236B	D26	DIODE, ZENER	
37	1			1N5930B	D24	DIODE, ZENER	

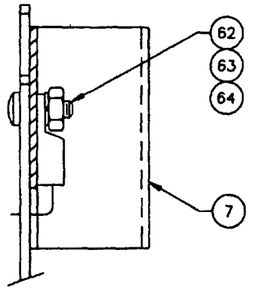
TRANSIT CONTROL SYSTEMS	TITLE: PA COMMUNICATIONS CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1166	REV. H	ADVANCE ____ RELEASE _X_
				SHEET 3 OF 4

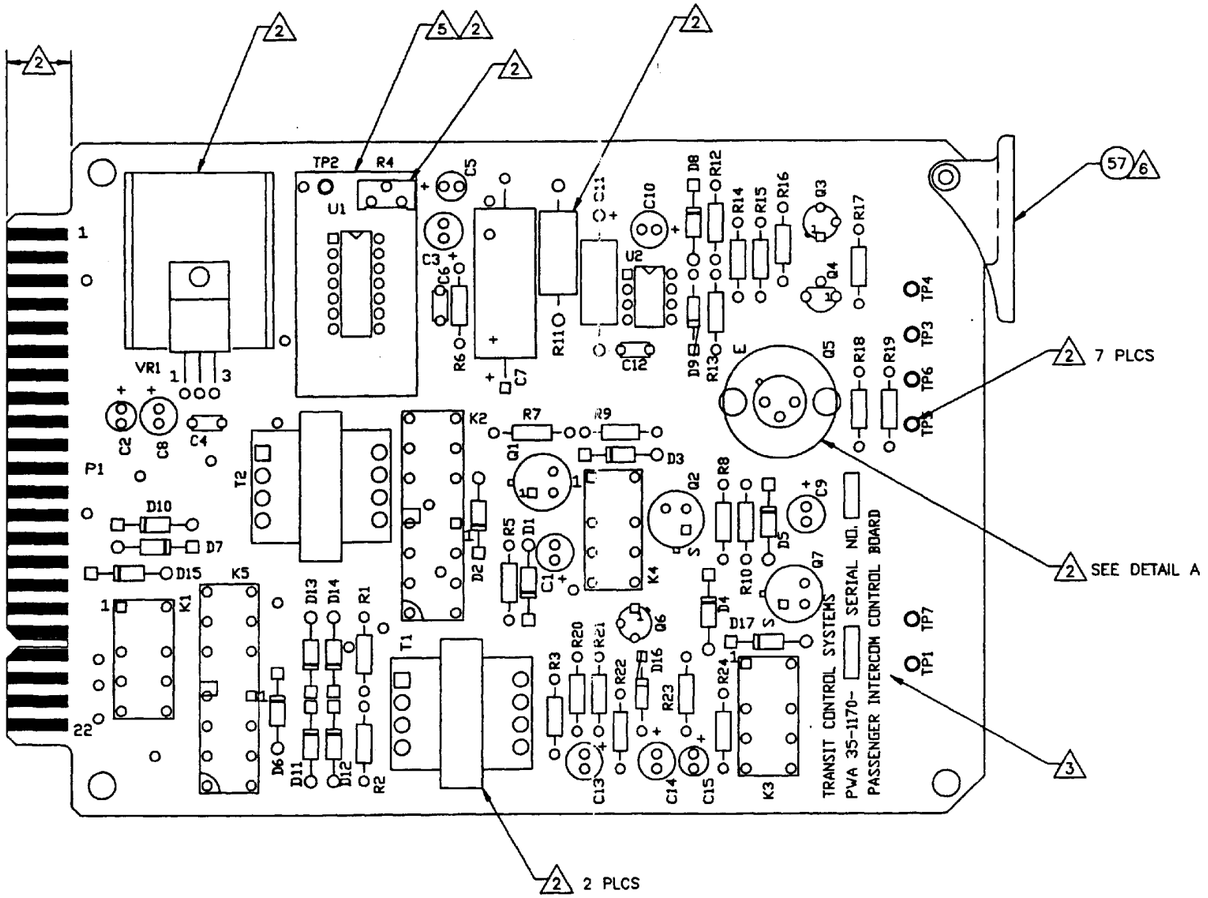
ITEM NO.	QTY REQD -104			PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
38	1			CKR05BX100KR	C13	CAP, CERAMIC, 10pF 200V, 10%	
39	1			CKR05BX102KR	C2	CAP, CERAMIC, .001uF 200V, 10%	
40							
41	1			CKR05BX473KR	C1	CAP, CERAMIC, .047uF 100V, 10%	
42	7			CKR05BX104KR	C8,10-12,C19,C25,C26	CAP, CERAMIC, .1uF 100V, 10%	
43	3			CKR06BX224KR	C9,17,18	CAP, CERAMIC, .22uF 50V, 10%	
44	2			CKR06BX474KR	C4,C5	CAP, CERAMIC, .47uF 50V, 10%	
45	2			CKR06BX105KR	C20,C21	CAP, CERAMIC, 1uF 50V, 10%	
46							
47							
48							
49	3			515D105M100JA6A	C6,C27,C28	CAP, ALUM. ELECT, 1uF 100V, 20%	SPRAGUE
50	1			ECEB1VV221S	C29	CAP, 220uF, 35V	PANASONIC
51	4			515D106M050JA6A	C15,C16,C24,C30	CAP, ALUM. ELECT, 10uF 50V, 20%	SPRAGUE
52	1			515D336M035JA6A	C23	CAP, ALUM. ELECT, 33uF 35V, 20%	SPRAGUE
53	2			515D476M050AA6A	C14,22	CAP, ALUM. ELECT, 47uF 50V, 20%	SPRAGUE
54	2			515D107M025AA6A	C3,C7	CAP, ALUM. ELECT, 100uF 25V, 20%	SPRAGUE
55							
56							
57							
58	1			RN55C1652F	R56	RESISTOR, 16.5K 1/8W 1%	
59	1			RN55C3322F	R55	RESISTOR, 33.2K 1/8W 1%	
60							
61							
62							
63							
64	2			RCR07G4R7JS	R35,36	RESISTOR, 4.7 1/4W 5%	
65	2			RCR07G220JS	R34,37	RESISTOR, 22 1/4W 5%	
66	2			RCR07G101JS	R2,12	RESISTOR, 100 1/4W 5%	
67	2			RCR07G471JS	R31,32	RESISTOR, 470 1/4W 5%	
68	1			RCR07G511JS	R1	RESISTOR, 510 1/4W 5%	
69	1			RCR07G102JS	R41	RESISTOR, 1K 1/4W 5%	
70	2			RCR07G202JS	R50,R51	RESISTOR, 2K 1/4W 5%	
71	1			RCR07G272JS	R33	RESISTOR, 2.7K 1/4W 5%	
72	2			RCR07G332JS	R4,53	RESISTOR, 3.3K 1/4W 5%	
73	1			RCR07G362JS	R13	RESISTOR, 3.6K 1/4W 5%	
74	1			RCR07G751JS	R66	RESISTOR, 750 OHM, 1/4W 5%	

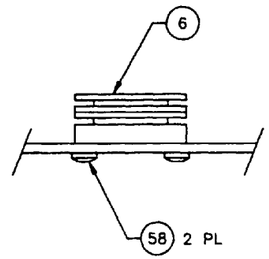
TRANSIT CONTROL SYSTEMS	TITLE: PA COMMUNICATIONS CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1166	REV. H	ADVANCE ____ RELEASE _X_
				SHEET 4 OF 4

ITEM NO.	QTY REQD -104			PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
75	1			RCR07G472JS	R59	RESISTOR, 4.7K 1/4W 5%	
76	1			RCR07G512JS	R16	RESISTOR, 5.1K 1/4W 5%	
77	1			RCR07G562JS	R40	RESISTOR, 5.6K 1/4W 5%	
78	3			RCR07G103JS	R52,54,60 (R42,43,45,47 -102 ONLY)	RESISTOR, 10K 1/4W 5%	
79	2			RN55D1502F	R42,43	RESISTOR, 15K, 1/8W, 1%	
80	2			RCR07G203JS	R44,46	RESISTOR, 20K 1/4W 5%	
81	2			RCR07G223JS	R63,64	RESISTOR, 22K 1/4W 5%	
82	1			RCR07G273JS	R3	RESISTOR, 27K 1/4W 5%	
83	1			RCR07G303JS	R7	RESISTOR, 30K 1/4W 5%	
84	4			RCR07G393JS	R11,17,61,62	RESISTOR, 39K 1/4W 5%	
85	1			RCR07G473JS	R14	RESISTOR, 47K 1/4W 5%	
86	2			RCR07G104JS	R22,24	RESISTOR, 100K 1/4W 5%	
87	1			RCR07G154JS	R6	RESISTOR, 150K 1/4W 5%	
88	2			RN55D4991F	R45,47 (-103 ONLY)	RESISTOR, 4.99K, 1/8W, 1%	
89	2			RCR07G204JS	R48,49	RESISTOR, 200K 1/4W 5%	
90	1			RCR07G274JS	R15	RESISTOR,270K 1/4W 5%	
91							
92	1			RCR07G334JS	R8	RESISTOR, 330K 1/4W 5%	
93	2			RCR07G474JS	R9,30	RESISTOR, 470K 1/4W 5%	
94	6			RCR07G105JS	R19,20,21,23,25,27	RESISTOR, 1MEG 1/4W 5%	
95	4			RCR07G205JS	R26,28,57,58	RESISTOR, 2MEG 1/4W 5%	
96	1			RCR07G514JS	R29	RESISTOR, 510K 1/4W 5%	
97	1			RCR20G102JS	R10	RESISTOR, 1K 1/2W 5%	
98	1			41J200	R38	RESISTOR, 200 1W 5%	OHMITE
99	1			42J390	R39	RESISTOR, 390 2W 5%	OHMITE
100	1			RN60D4750F	R68	RESISTOR, 475 OHM, 1/4W, 1%	
101	1			3386H-1-502	R5	RESISTOR, VARIABLE, 5K	BOURNS
102	1			3386H-1-203	R18	RESISTOR, VARIABLE, 20K	BOURNS
103	1			RN60D2210F	R67	RESISTOR, 221 OHM, 1/4W, 1%	
104	1			RN55C4022F	R65	RESISTOR, 40.2K, 1/8W, 1%	
105	1			5021		EJECTOR, CARD	THERMALLOY
106	7			2031B	TP1-TP7	TERMINAL, TURRET, .042 DIA	USECO
107	4			2030B		TERMINAL, TURRET, .062 DIA	USECO
108							
109							
110							
111	A/R				JUMPERS	28AWG, SOLID, INSULATED	

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
–	INITIAL RELEASE	2/11/93	BC
A	CREATED -102 CONFIG	9-29-94	BC







DETAIL A

6 INSTALL AFTER CONFORMAL COATING.

5 SOLDER HEATSINK (ITEM 39) TO U1 PINS 3,4,5,10,11 & 12.

4. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 35–4171.

3 RUBBER STAMP ASSEMBLY DASH NO. AND SERIAL NO. WHERE SHOWN USING .12 CHARACTERS, COLOR BLACK. COVER WITH CLEAR LACQUER.

2 DO NOT APPLY CONFORMAL COAT TO COMPONENTS INDICATED.

1. CONFORMAL COAT BOTH SIDES OF CLEANED PRINTED WIRING ASSEMBLY PER MIL–STD–275 AFTER TESTING.

NOTES: UNLESS OTHERWISE SPECIFIED

SEE SEPARATE PARTS LIST

11-3.259

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NOTE
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DASH	APPLICATION
102	35–1160
	NEXT ASSY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMAL .X ±.1 .XX ±.03 .XXX ±.015
ANGLES ±30'
FRACTIONS ±1/16
HOLE DIAMETERS
.000/.125 +.001 -.001
.126/.250 +.005 -.001
.251/.500 +.006 -.001
.501/.750 +.008 -.001
.751/1.000 +.010 -.001
1.001/2.000 +.012 -.001
DO NOT SCALE DRAWING

		DATE
DRAWN	HITCHCOCK,J	1-21-93
CHECKED		
MECH ENG		
ELECT ENG		
PROD ENG		
CHIEF ENG		
CUST. APPROVAL		
CONTRACT NO.		

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE
PRINTED WIRING ASSEMBLY
PASS. INTERCOM CONTROL BD

SIZE	CODE IDENT NO.		REV.
D		35–1170	A

SCALE 2/1 PLOT SCALE: 1/1 SHEET 1 OF 1

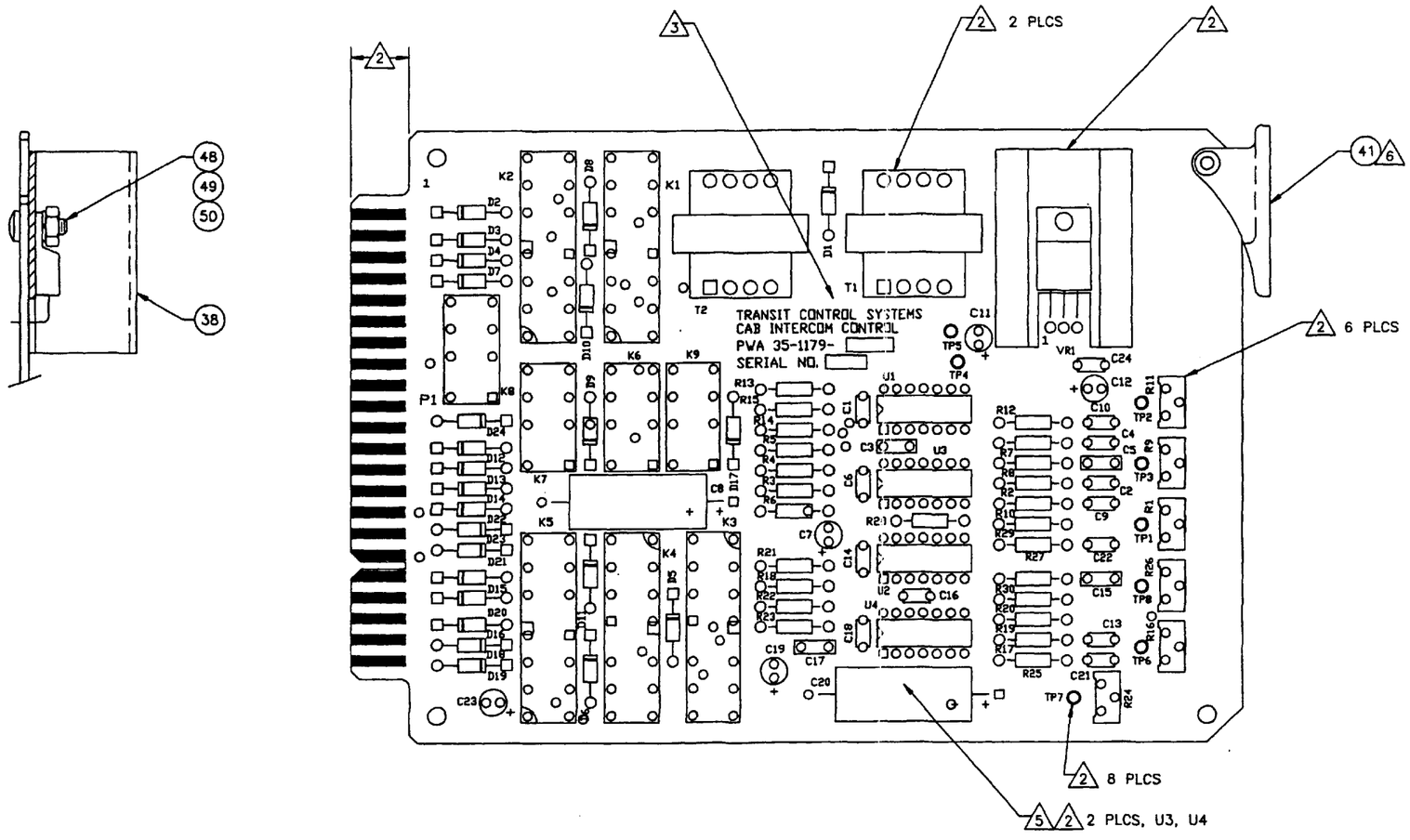
TRANSIT CONTROL SYSTEMS	TITLE: PASSENGER INTERCOM CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1170	REV. A	ADVANCE ___ RELEASE X
				SHEET 2 OF 3

ITEM NO.	QTY REQD -101	QTY REQD -102		PART NO.	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
1	1	–		35-2172-1		PWB, PASSENGER INTERCOM CONTROL	
2	–	1		35-2172-2		PWB, PASSENGER INTERCOM CONTROL	
3	REF	REF		35-4171		SCHEMATIC, PASS INTERCOM CONTROL	
4							
5	1	1		580200B00000	XU1	HEAT SINK	AAVID
6	1	1		2215B	XQ5	HEAT SINK, TO-5	THERMALLOY
7	1	1		530600	XVR1	HEAT SINK	AAVID
8	1	1		LM384N	U1	IC, 5W AUDIO AMP	NATIONAL
9	1	1		LM555CN	U2	IC, LINEAR TIMER	NATIONAL
10	1	1		MC78M24CT	VR1	VOLTAGE REGULATOR, 24V 500mA	MOTOROLA
11	3	3		AZ830-2C-24DE	K1,K3,K4	RELAY, MINIATURE 24V DPDT 2'C'	AMER. ZETTLER
12	2	2		AZ830-4C-24DEA	K2,K5	RELAY, MINIATURE 24V 4PDT 4'C'	AMER. ZETTLER
13							
14	2	2		120-6103-001	T1, T2	TRANSFORMER, AUDIO	TCS
15							
16	1	1		LM395H	Q5	TRANSISTOR, NPN HIGH POWER	NATIONAL
17							
18	2	2		2N6661	Q2,Q7	TRANSISTOR, FIELD EFFECT	SILICONIX
19	2	2		2N2222A	Q3,Q6	TRANSISTOR, NPN	
20	1	1		2N2905A	Q1	TRANSISTOR, PNP	
21	1	1		2N4403	Q4	TRANSISTOR, PNP	
22	2	2		1N914A	D9,D16	DIODE, RECTIFIER	
23	13	13		1N4007	D1,2,3,4,6,7,10-15,17	DIODE, RECTIFIER	
24	1	1		1N4742A	D8	DIODE, ZENER, 12V	
25	1	1		1N4744A	D5	DIODE, ZENER, 15V	
26							
27	1	1		RCR07G2R7JS	R6	RES, 2.7 OHMS, 5%, 1/4W	
28	3	3		RCR07G621JS	R1,2,3	RES, 620 OHMS, 5%, 1/4W	
29	1	1		RCR07G102JS	R7	RES, 1K, 5%, 1/4W	
30	1	1		RCR07G152JS	R20	RES, 1.5K, 5%, 1/4W	
31	3	3		RCR07G472JS	R8,16,22	RES, 4.7K, 5%, 1/4W	
32	5	5		RCR07G103JS	R5,15,17,18,21	RES, 10K, 5%, 1/4W	
33	2	2		RCR07G153JS	R9,10	RES, 15K, 5%, 1/4W	
34	2	2		RCR07G473JS	R14,19	RES, 47K, 5%, 1/4W	
35	1	1		RCR07G823JS	R12	RES, 82K, 5%, 1/4W	
36	1	1		RCR07G104JS	R13	RES, 100K, 5%, 1/4W	
37	2	2		RCR07G333JS	R23,24	RES, 33K, 5%, 1/4W	

TRANSIT CONTROL SYSTEMS	TITLE: PASSENGER INTERCOM CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1170	REV. A	ADVANCE ___ RELEASE _X_
				SHEET 3 OF 3

ITEM NO.	QTY REQD -101	-102		PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
38	1	1		43J1K5	R11	RES, POWER WIREWOUND, 1.5K, 3W	OHMITE
39							
40	1	1		3386H-1-103	R4	RES, VARIABLE PC MOUNT 10K	BOURNS
41							
42							
43							
44	1	1		515D105M100JA6A	C15	CAP, ALUM ELECT, 1uF, 100V	SPRAGUE
45	1	1		500D685M063BA2A	C11	CAP, ALUM ELECT, 6.8uF, 63V	SPRAGUE
46	4	4		515D106M100AA6A	C1,8,9,14	CAP, ALUM ELECT, 10uF, 100V	SPRAGUE
47	3	3		515D476M050AA6A	C3,10,13	CAP, ALUM ELECT, 47uF, 50V	SPRAGUE
48	1	1		515D334M050JA6A	C2	CAP, ALUM ELECT, .33uF, 50V	SPRAGUE
49							
50	1	1		516D477M035NR6A	C7	CAP, ALUM ELECT, 470uF, 35V	SPRAGUE
51	1	1		515D475M050JA6A	C5	CAP, ALUM ELECT, 4.7uF, 50V	SPRAGUE
52	1	1		CKR05BX103KR	C12	CAP, CERAMIC RADIAL LEAD .01uF, 100V	
53	2	2		CKR05BX104KR	C4,6	CAP, CERAMIC RADIAL LEAD .1uF, 50V	
54							
55							
56							
57	1	1		5021		EJECTOR, CARD	THERMALLOY
58	2	2		MS51957-3		SCREW, PAN HEAD, 2-56UNC x .25 LG	
59	7	7		2031B	TP1-7	TEST POINT, TURRET	USECO
60							
61							
62	1	1		MS51957-15		SCREW, PAN HEAD, 4-40UNC X .38 LG	
63	1	1		MS35338-154		WASHER, LOCK, #4	
64	1	1		MS35649-244		NUT, HEX, 4-40UNC	
65							
66							
67							
68							
69							
70							
71							
72							
73							
74							

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	INITIAL RELEASE	2-11-93	B.C.
A	ADDED -102 TO APPLICATION BOX.	1-3-94	B.C.
B	ADDED ORIENTATION INDICATORS TO RELAYS	3-8-94	B.C.
C	CREATED -103 CONFIG	9-29-94	BC



6. INSTALL AFTER CONFORMAL COATING.

5. SOLDER HEATSINK (ITEM 39) TO U3 & U4 PINS 3,4,5,10,11 & 12.

4. FOR SCHEMATIC DIAGRAM, SEE DRAWING NO. 35-4180.

3. RUBBER STAMP ASSEMBLY DASH NO. AND SERIAL NO. WHERE SHOWN USING .12 CHARACTERS, COLOR BLACK. COVER WITH CLEAR LACQUER.

2. DO NOT APPLY CONFORMAL COAT TO COMPONENTS INDICATED.

1. CONFORMAL COAT BOTH SIDES OF CLEANED PRINTED WIRING ASSEMBLY PER MIL-STD-275 AFTER TESTING.

NOTES: UNLESS OTHERWISE SPECIFIED

SEE SEPARATE PARTS LIST

11-3.265

PROPRIETARY NOTICE

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NOTE

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103	35-1160	
DASH	NEXT ASSY	
	APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMAL: .X ±.1, .XX ±.03, .XXX ±.015 — ANGLES ±30' — FRACTIONS ±1/16

HOLE DIAMETERS: .800/.125 +.004 -.001; .301/.750 +.008 -.001; .126/.250 +.005 -.001; .751/1.880 +.010 -.001; .251/.500 +.006 -.001; 1.881/2.880 +.012 -.001

DO NOT SCALE DRAWING

DRAWN	HITCHCOCK,J	1-21-93
CHECKED	B.C.	2-11-93
MECH ENG		
ELECT ENG	B.T. BLEACHER	2-11-93
PROD ENG		
CHIEF ENG	JOHN G. KIEL	
CUST. APPROVAL		
CONTRACT NO.		

TRANSIT CONTROL SYSTEMS
A Division of THE ANELLO CORPORATION

TITLE: PRINTED WIRING ASSEMBLY
CAB INTERCOM CONTROL BD

SIZE	CODE IDENT NO.		REV.
D		35-1179	C

SCALE: 2/1 PLOT SCALE: 1/1 SHEET 1 OF 1

TRANSIT CONTROL SYSTEMS	TITLE: CAB INTERCOM CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1179	REV. D	ADVANCE ___ RELEASE _X_
				SHEET 2 OF 3

ITEM NO.	QTY REQD -101	QTY REQD -102	QTY REQD -103	PART NO.	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
1	1	–	–	35-2181-1		PWB, CAB INTERCOM CONTROL BD	
2	REF	REF	REF	35-4180		SCH, CAB INTERCOM CONTROL BD	
3	–	–	1	35-2181-3		PWB, CAB INTERCOM CONTROL BD	
4	–	1	–	35-2181-2		PWB, CAB INTERCOM CONTROL BD	
5							
6							
7	4	4	4	AZ830-2C-24DE	K6,K7,K8,K9	RELAY, 24V DPDT, 2'C'	AMER. ZETTLER
8	5	5	5	AZ830-4C-24DEA	K1-K5	RELAY, 24V 4PDT, 4'C'	AMER. ZETTLER
9							
10	2	2	2	120-6103-001	T1,T2	TRANSFORMER, AUDIO	TCS
11	–	–	1	MC78M24CT	VR1	IC, VOLTAGE REGULATOR, 24V	MOTOROLA
12	2	2	2	LM2900N	U1,U2	IC, LINEAR OPERATIONAL AMP, QUAD	NATIONAL
13	2	2	2	LM384N	U3,U4	IC, AUDIO POWER AMPLIFIER, 5 WATT	NATIONAL
14	1	1	–	MC7815CT	VR1	IC, VOLTAGE REGULATOR, 15V	MOTOROLA
15	24	24	24	1N4007	D1-D24	DIODE, RECTIFIER	
16							
17	2	2	2	CKR05BX220M	C4,C16	CAP, CERAMIC, RADIAL, 22pF, 200V, 20%	
18	11	11	11	CKR05BX104KR	C1,2,6,9,10,13,14,18,21,22,24	CAP, CERAMIC, RADIAL, 0.1uF, 50V, 10%	
19	4	4	4	CKR06BX474KR	C3,5,15,17	CAP, CERAMIC, RADIAL, .47uF, 50V, 10%	
20							
21	1	1	1	515D334M050JA6A	C11	CAP, ALUM ELECT., .33uF, 50V, 20%	SPRAGUE
22	2	2	2	515D475M050JA6A	C7,C19	CAP, ALUM ELECT., 4.7uF, 50V, 20%	SPRAGUE
23	1	2	2	515D476M050AA6A	C12,23	CAP, ALUM ELECT., 47uF, 50V, 20%	SPRAGUE
24	2	2	2	516D477M035NR6A	C8,C20	CAP, ALUM ELECT., 470uF, 35V, 20%	SPRAGUE
25							
26							
27							
28							
29	2	2	2	RCR07G2R7JS	R10,R25	RESISTOR, 2.7 OHM, 1/4W, 5%	
30	8	2	2	RCR07G104JS	R8,23	RESISTOR, 100K, 1/4W, 5%	
31	2	4	4	RCR07G184JS	R5,15,20,30	RESISTOR, 180K, 1/4W, 5%	
32	2	2	2	RCR07G474JS	R7,R22	RESISTOR, 470K, 1/4W, 5%	
33	6	10	10	RCR07G105JS	R2,4,6,12,14,17,19,21,27,29	RESISTOR, 1 MEG, 1/4W, 5%	
34	4	4	4	RCR07G205JS	R3,R13,R18,R28	RESISTOR, 2 MEG, 1/4W, 5%	
35							
36	4	4	4	3386H-1-502	R1, R11, R16, R26	RESISTOR, VARIABLE, 5K	BOURNS
37	2	2	2	3386H-1-103	R9, R24	RESISTOR, VARIABLE, 10K	BOURNS

TRANSIT CONTROL SYSTEMS	TITLE: CAB INTERCOM/RADIO CONTROL BOARD ASSEMBLY PARTS LIST	PARTS LIST NO. PL35-1179	REV. D	ADVANCE ___ RELEASE _X_
				SHEET 3 OF 3

ITEM NO.	QTY REQD -101	-102	-103	PART NO.	REF DESIG.	DESCRIPTION	MANUFACTURER
38	1	1	1	530614	XVR1	HEATSINK	AAVID
39	2	2	2	580200B00000	XU3,XU4	HEATSINK, IC	AAVID
40							
41	1	1	1	5021		EJECTOR, CARD	THERMALLOY
42	8	8	8	2031B	TP1-TP8	TEST POINT, TURRET	USECO
43							
44							
45							
46							
47							
48	1	1	1	MS51957-15		SCREW, PAN HEAD, 4-40UNC X 3/8 LG	
49	1	1	1	MS35338-154		WASHER, FLAT, #4	
50	1	1	1	MS35649-244		NUT, HEX, 4-40UNC	
51							
52							
53							
54							
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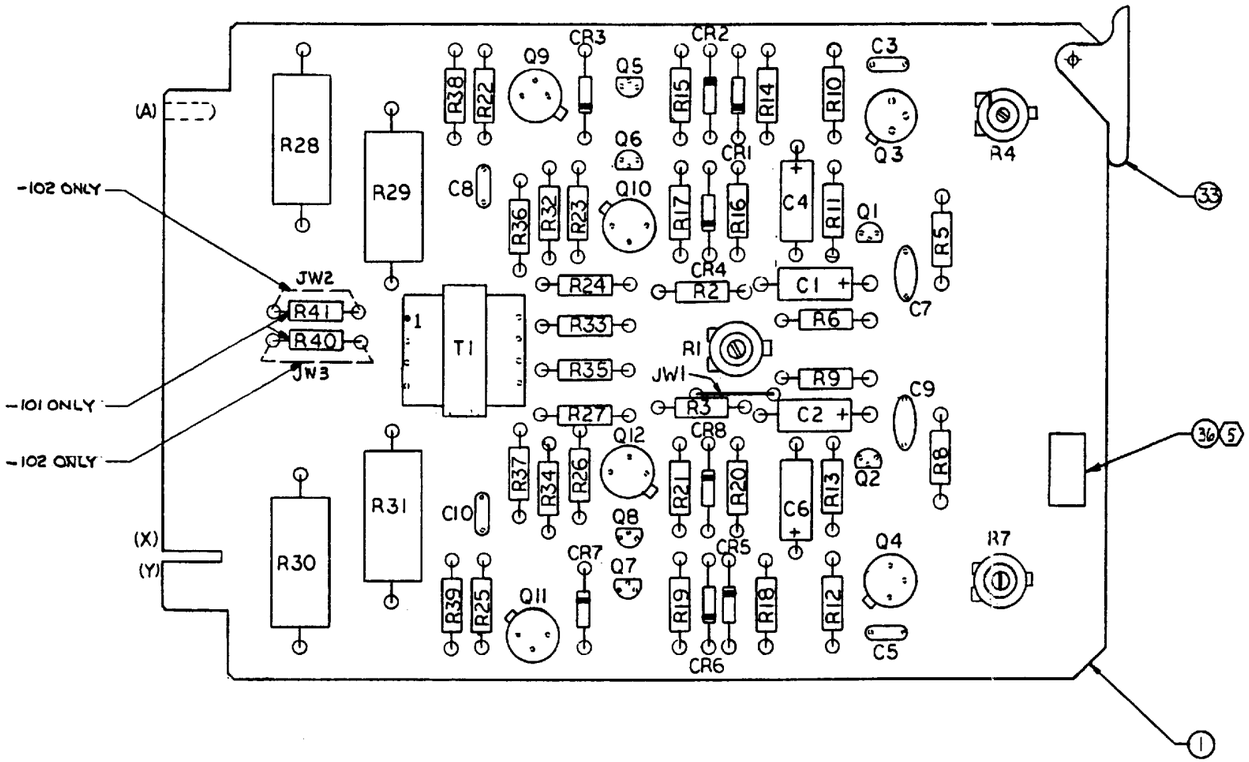
72							
73							
74							

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
-	RELEASE	4/11/81	
X1	RELEASE FOR PROTOTYPE	11/30/81	
X2	REVERSED INSTL. OF CR1 & CR2	7/12/82	
X3	ADDED -102 ASSEMBLY	6/17/87	
X4	ITEM 28 WAS P/N 7CX7R224X9100D2	11/9/89	
X5	ADDED CONTRACT NO. & BART TO TITLE BLOCK	9/1/88	
A	RELEASED FOR PRODUCTION	10/3/88	
B	ADDED CONTRACT NO.	1-8-93	
C	ITEM 3 WAS P/N PC-0-35. UTC/TRW	7-28-93	
D	ADDED ITEM 36 & NOTE 5.	9-10-93	



		38					
		37					
1	-	36	10-9051	BAR CODE LABEL		TCS	
		35					
AR	AR	34	22AWG	WIRE SOLID	JW1, JW2, JW3.		
1	1	33	S203	EJECTOR		SCANBE	
		32					
8	8	31	IN4007	DIODE	CR1-8		
		30					
2	2	29	TG-P10	CAPACITOR	C7,9	SPRAGUE	.1µF 100V
2	2	28	2C25X7R224KO50B	↕	C8,10	↕	.22µF, 50V
2	2	27	TE-1155	↕	C4,6	↕	10µF, 16V
2	2	26	5GA Q12	↕	C3,5	↕	12PF, 1KV
2	2	25	TE-1200	CAPACITOR	C1,2	SPRAGUE	1µF, 25V
		24					
2	2	23	PT10V-100K	RESISTOR,VAR.	R4,7	PIHER	100K
1	1	22	PT10V-10K	RESISTOR,VAR.	R1	PIHER	10K
		21					
2	2	20	RCR20G100JS	RESISTOR	R36,37		10 OHMS 1/2W 10%
2	2	19	682	↕	R33,35		6.8K
2	2	18	103	↕	R32,34		10K
2	2	17	472	↕	R11,13		4.7K
2	2	16	270	↕	R15,19		27
8	8	15	101	↕	R14,16,18,20,22,24,25,27		100
2	2	14	223	↕	R10,12		22K
2	2	13	683	↕	R5,8		68K
2	2	12	333	↕	R6,9		33K
8	10	11	RCR20G102JS	↕	R2,3,17,21,23,26,38÷41		1K OHMS, 1/2W, 5%
4	4	10	PW5-.1OHMS 10%	RESISTOR	R28÷31	IRC/TRW	.1OHMS, 5W, 10%
		9					
2	2	8	2N4238	TRANSISTOR	Q9,11		
4	4	7	2N4235	↕	Q3,4,10,12		
2	2	6	2N3906	↕	Q6,8		
4	4	5	2N3904	TRANSISTOR	Q1,2,5,7		
		4					
1	1	3	120-6106-001	TRANSFORMER	T1	TCS	
		2					
1	1	1	37-2042-1	BOARD			

102 DASH	101 DASH	ITEM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	REF. DESIG.	MANUFACTURER	DATA
QTY REQD PER ASSY			PARTS LIST / LIST OF MATERIAL				

(5) APPLY BAR CODE LABEL APPROX WHERE SHOWN.

4. RUBBER STAMP PART AND SERIAL NUMBERS IN AREA PROVIDED ON CIRCUIT SIDE.
3. CONFORMAL COAT .0003-.0007 THICK. COAT ENTIRE BOARD, EXCEPT, R28-31, R1 R4, R7 AND CONTACT AREA.
2. ACCEPTANCE TEST ASSEMBLY PER PROCEDURE, 35-7041
1. SCHEMATIC DIAGRAM, 37-4041

NOTES:

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
.X DECIMAL ±
.XX DECIMAL ±
.XXX DECIMAL ±
ANGLES ±
FRACTIONS ±

DRAWN J.G. KIEL 11/3/81
CHECKED
APPROVAL
APPROVAL
APPROVAL
CUST. APPROVAL
CONTRACT NO. 42AA-110 & 42DA-110

TRANSIT CONTROL SYSTEMS

TITLE
ASSEMBLY
POWER AMPLIFIER

SIZE D | CODE IDENT NO. | 37-1040 | REV. D

2/1

SHEET 1 OF 1

11-3.271

11-3.8 Piping and Pneumatic Drawings (P&PD) (Not Applicable)

Table 11-3.7 COMMUNICATION SYSTEM – P&PD LIST

S/N	BCF FILE # ---------- SUPPLIER FILE #	TITLE	PAGE	NOTE
NOT APPLICABLE				

INTENTIONALLY LEFT BLANK

SECTION 11-1

COMMUNICATIONS

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SECTION 11-1

COMMUNICATIONS

INTRODUCTION

11-1.1 Abbreviations, Acronyms and Symbols

11-1.1.1 List of Abbreviations, Acronyms and Symbols

The Abbreviations, Acronyms and Symbols commonly used throughout this section are given below with their relevant meaning.

Abbreviation	Meaning
AC	Alternative Current
ACDBS	Alternative Current Dead Battery Start
Art. Sect.	Articulation Section
Assy	Assembly
ATCS	Automatic Train Control System
°C	Degrees Centigrade
Cont'd	Continued
CONN.	Connector
DC	Direct Current
DIA	Diameter
DTE	Diagnostic Test Equipment
DU	Disconnect Unit
DWG	Draw
E.I.C.	Equipment Identification Code
ECBCL	Equipment Circuit Boards Component Layout
ECBS	Equipment Circuit Boards Schematics
EQUIP. LOC.	Equipment Location
ET	Electric Trainlines
Fig./fig.	Figure
FWD	Forward
H-PM	Heavy Preventive Maintenance
HRWM	Heavy Repair and Workshop Manual
HV	High Volt age
HVAC	Heat Ventilating Air Conditioning
Hz	Hertz (Frequency measure)

List of Abbreviations, Acronyms and Symbols (cont'd)

Abbreviation	Meaning
in	Inches (Linear measure)
IWD	Integrated Wiring Diagrams
IWT	Integrated Wiring Tables
lb	Pounds (Weight measure)
LH	Left Hand
L.I.	Location Illustrations
LOC	Location
LRV	Light Rail (Transit) Vehicle
LV	Low Voltage
LVPS	Low Voltage Power Supply
MUNI	San Francisco Municipal Railway
oz	Ounces (Weight measure)
P.M.	Preventive Maintenance
P/N	Part Number
para(s)	Paragraph(s)
P & PD	Piping and Pneumatic Drawing
PSIG	Pounds per Square Inch Gauge
REDI	Raceway External Diameter Identification
REV	Revision
RH	Right Hand
RMSM	Running Maintenance and Service Manual
RWI	Raceway Wiring Identification
Qty	Quantity
r.p.m.	Revolutions Per Minute
SAE	Society of American Engineers
TB	Terminal Board
TBS	To be Supplied
TERM. BOARD	Terminal Board
VAC	Volt Alternating Current
VDC	Volt Direct Current
VOBC	Vehicle On Board Controller
WIRE ID	Wire Identification

11-1.1.2 List of Definitions

The Definitions commonly used throughout this section are given below with their relevant meaning.

Abbreviation	Definition
"A" Body Section	The half of an articulated vehicle containing the pantograph.
AFT Truck Side	The side of the truck ("A" or "B") on which the pilot bar is not fitted.
"A" Motor Truck	The motor truck installed under "A" Body Section.
"B" Body Section	The half of an articulated vehicle not containing the pantograph.
"B" Motor Truck	The motor truck installed under "B" Body Section.
"C" Truck	The trailer truck installed under the articulation section.
Console	The control panel located in the cab directly in front of the operator's seat.
Corrective maintenance	Those actions performed, as a result of a failure to restore an item to a specified condition.
Failure	The inability of a system, subsystem, assembly, or component to perform its required function.
FWD Truck Side	The side of the truck ("A" or "B") on which the pilot bar is fitted.
High Voltage	High voltage 600 VDC.
Left Hand	Left side of transit vehicle when one looks toward the "A" Body Section Operator's cab from inside the vehicle.
Low Voltage	The voltage used for most auxiliary equipment on the vehicle, usually between 24 and 72 VDC or 110 to 240 VAC.
Muni-Supplied Equipment	Equipment furnished by MUNI to the Contractor for installation in or on the transit vehicle.
Operator	Individual on board who is responsible for train operation in manual modes and for overseeing train operation in the automatic mode.

List of Definitions (cont'd)

Abbreviation	Definition
Pantograph	A device used for current collection from a catenary system. It consists of a dual-strip electrical collection shoe carried by a collapsible and adjustable frame.
Right Hand	Right side of the transit vehicle when one looks toward the "A" Body Section Operator's cab from inside the vehicle.
Trailer Truck	The truck installed under articulation section.
Truck LH Side	The side of the truck on which the MFR name is fitted and the wheels are identified by odd numbers (1 & 3).
Truck RH Side	The side of the truck on which the wheels are identified by even numbers (2 & 4).

11-1.2 General

The IWD Manual (IWDM) provides Instructions, Wiring Data, Wiring Diagrams/Schematics, Equipment Circuit Boards Data/Schematics and Pneumatic Drawings for performing LRV2 (Vehicles # 1400 through 1476) Troubleshooting and Fault Isolation.

The information/data are provided by Volumes (A through P), each one consistent with the relevant Sections of the RMSM, HRWM, R-PMM, H-PMM and DTE and Special Tools.
This Volume M 04-J provides the above contents for the COMMUNICATIONS.

In addition, to help the Maintainers for viewing the entire systems during troubleshooting, a complete collection of BREDA DWG 4.00.000 SCHEMATICS is provided in Volume M 04 -Q.

11-1.3 Arrangement

11-1.3.1 Volumes Arrangement

♦ **Volumes A through P**

Each of the IWD Manual's Volumes (A through P) consists of 3 Sections as follows:

XX-1 Introduction

XX-2 System Description, Fault Isolation, Adjustment/Test and DTE & Special Tools

XX-3 Integrated Wiring Data and Diagrams/Schematics Collection

NOTE: "XX" Indicates the System Code (consistent with RMSM, HRWM, R-PMM, H-PMM and DTE & Special Tools Manual) as follows:

System Code	System	System Code	System
02	CAR BODY	09	AIR COMFORT SYSTEM
03	TRUCKS AND SUSPENSION	10	LIGHTING
04	PROPULSION AND ELECTRONIC CONTROLS	11	COMMUNICATIONS
05	HIGH VOLTAGE/LOW VOLTAGE POWER DISTRIBUTION	12	DESTINATION SIGN
06	AIR COMPRESSOR /PNEUMATIC SYSTEM	13	Unassigned
07	COUPLER AND DRAFT GEAR	14	Unassigned
08	DOORS AND STEPS	15	PANTOGRAPH
		16	BRAKES
		17	TRAIN CONTROL (ATCS)

♦ **Volume Q**

The Volume Q consists of 2 Sections as follow:

Section 1 Introduction.

Section 2 BREDA DWG 4.00.000 Schematics Collection.

11-1.3.2 Volumes Content

♦ **Volumes A through P**

- The **INTRODUCTION** section provides:
  - Abbreviations, Acronyms and Symbols used through the Volume
  - Volume's Applicability, Arrangement and Instructions for users
  - General Safety Precautions
  - Vehicle's Hazard Areas
  - Vehicle's HV – LV Power Distribution
  - Vehicle's Component Identification
  - On Vehicle Equipment Location and Equipment Identification Codes
  - On Vehicle Raceway and Wiring Identification and Location (Tables)
  - Vehicle's Trainline Wires List
  - Vehicle's Systems Integration
  - Vehicle's Systems Integrated Wirings & Circuit Boards Data, Diagrams, Schematics and Maintenance Manuals Cross Reference (Tables)
  - Running Preventive Maintenance Matrix (System Based)
  - Heavy Preventive Maintenance Matrix (System Based)
  - Running Maintenance – List of Consumable Materials
  - Heavy Maintenance – List of Consumable Materials
  - MUNI Cleaning Products List.

- The **"DESCRIPTION, FAULT ISOLATION, ADJUSTMENT/TEST and DTE & Special Tools"** section provides:
  - Abbreviations, Acronyms and Symbols used through the Section
  - System/Subsystem/Equipment Description and Operation
  - System/Subsystem/Equipment Specific Safety Precautions
  - System/Subsystem/Equipment Fault Isolation (Tables)
  - Equipment Adjustment/Test
  - DTE & Special Tools needed to perform System/Subsystem Maintenance Tasks with their relevant Descriptions and Operations.

- The **"INTEGRATED WIRINGS DATA AND DIAGRAMS/SCHEMATICS COLLECTION "** section provides:
  - Abbreviations, Acronyms Symbols used through the Section.
  - Detailed explanation (in text and/or table forms) of Data and Drawings Ordering, Arrangement and Cross-References.
  - (System's) Integrated Wiring Diagrams (IWD).

- Subsystems Internal Wiring Diagrams (SIWD).
- (System's) Integrated Wiring Tables (IWT) and their relevant Raceway Location and Identification.
- Equipment Circuit Boards Schematics (ECBS).
- Equipment Circuit Boards Component Layout (ECBCL).
- Piping & Pneumatic Drawings (P &PD).

♦ **Volume Q**

The Volume Q consists of 2 Sections as follow:

The **INTRODUCTION** section provides Information applicable to the whole Vehicle and Instructions for proper Volume or Section(s) use.

The **BREDA DWG 4.00.000 Schematics Collection** provides electrical connections with Vehicle's Systems, Subsystems and/or Equipment.

11-1.3.3 Manual Arrangement

The Integrated Wiring Diagrams Manual (IWDM) consists of 17 volumes identified as Volumes M04 A through M04 Q.
Some Volumes consist of two or more binders, in function of their content; in this case the Titles of the Documentation collected in each binder are detailed in the list provided below.

Volume M 04 - A CAR BODY

SECTION 2-1 - Introduction
SECTION 2-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 2-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - B TRUCKS AND SUSPENSION

SECTION 3-1 - Introduction
SECTION 3-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 3-3 - Integrated Wirings Data and Diagrams/Schematics Collection

Volume M 04 - C PROPULSION AND ELECTRONIC CONTROLS

BINDER **I** SECTION 4-1 - Introduction
SECTION 4-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools

BINDER **II** SECTION 4-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(IWD)**

BINDER **III** SECTION 4-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(SIWD) - (IWT)**

Volume M 04 - C PROPULSION AND ELECTRONIC CONTROLS (cont'd)

BINDER **IV** SECTION 4-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(ECBS)**

BINDER **V** SECTION 4-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(ECBCL) - (P&PD)**

Volume M 04 - D HV/LV POWER DISTRIBUTION

BINDER **I** SECTION 5-1 - Introduction
SECTION 5-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools

BINDER **II** SECTION 5-3 - Integrated Wirings Data and Diagrams/Schematics Collection **(IWD)**

BINDER **III** SECTION 5-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(SIWD)**

BINDER **IV** SECTION 5-3 - Integrated Wirings Data and Diagrams/ Schematics Collection **(IWT) (ECBS) - (ECBCL) - (P&PD)**

Volume M 04 - E AIR COMPRESSOR / PNEUMATIC SYSTEM

SECTION 6-1 - Introduction
SECTION 6-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 6-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - F COUPLER AND DRAFT GEAR

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Volume M 04 - G DOORS AND STEPS

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SECTION 8-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools

BINDER **II** SECTION 8-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - H AIR COMFORT SYSTEM

SECTION 9-1 - Introduction
SECTION 9-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 9-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - I LIGHTING
SECTION 10-1 - Introduction
SECTION 10-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 10-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - J COMMUNICATIONS
BINDER **I** SECTION 11-1 - Introduction
SECTION 11-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
BINDER **II** SECTION 11-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - K DESTINATION SIGN
SECTION 12-1 - Introduction
SECTION 12-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 12-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - L Unassigned

Volume M 04 - M Unassigned

Volume M 04 - N PANTOGRAPH
SECTION 15-1 - Introduction
SECTION 15-2 - Description, Fault Isolation, Adjustment/Test, DTE and Special Tools
SECTION 15-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - O BRAKES
BINDER **I** SECTION 16-1 - Introduction
SECTION 16-2 - Description, Fault Isolation, Adjustment/Test, DTE And Special Tools
BINDER **II** SECTION 16-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - P TRAIN CONTROL (ATCS)
BINDER **I** SECTION 17-1 - Introduction
SECTION 17-2 - Description, Fault Isolation, Adjustment Test, DTE And Special Tools
BINDER **II** SECTION 17-3 - Integrated Wirings Data and Diagrams/ Schematics Collection

Volume M 04 - Q BREDA DWG 4.00.000 SCHEMATICS COLLECTION
SECTION 1 - Introduction
SECTION 2 - BREDA DWG 4.00.000 Schematics Collection

11-1.4 How to Use this Volume

This Volume provides Wiring Data, System and Subsystem Wiring Diagrams, Schematics, Circuit Board Component Layouts and Piping and Pneumatic Drawings for the COMMUNICATIONS.

This Volume consists of 3 Sections , as follows

Section 1 INTRODUCTION provides Technical Data and Information applicable to the Whole Vehicle and Detailed Instructions for proper Volume or Section (s) use.

Section 2 DESCRIPTION, FAULT ISOLATION, ADJUSTMENT/ TEST and DTE & Special tools summarizes the COMMUNICATIONS Maintenance Information provided in RMSM HRWM, R-PMM, H-PMM and DTE & Special tools Manual.

Section 3 INTEGRATED WIRING DATA AND DIAGRAMS/ SCHEMATICS COLLECTION provides IWD, SIWD, IWT, ECBS, ECBCL and P & PD pertaining to the COMMUNICATIONS and relevant instructions for their proper use.

It is suggested to read accurately this Section 11-1 before to proceed with other Sections. Particularly read:

1. Para 11-1.9 before performing any Maintenance Activities.
2. List of Volumes (page – iii of any Volumes) to know which Volume is to be used when a faulty System is found.
3. Refer to paragraphs 11-1.14 through 11-1.14.3 before using the RWI Tables furnished in 11-1.14.4.
4. Refer to paragraphs 11-1.15 through 11-1.15.2 before using the IWT Tables furnished paragraphs 11-3.5 through 11-3.5.2.
5. Refer to paragraphs 11-1.12 through 11-1.12.3 in conjunction with Figure 11-1.10 and paragraph 11-1.16 before using the specific Communications IWD Volume.
6. Refer to paragraph 11-1.17 before using the specific applicable Communications SIWD.

It is also suggested to refer to :

1. Para 11-1.1 any time you need to know the detailed definitions of any Abbreviations and Acronyms found in the text.

2. Table 11-1.2 any time you need to know the Equipment Identification Code of any Equipment installed on Vehicle.

3. Table 11-1.2 in conjunction with Fig. 11-1.11, 11-1.12 and 11-1.13 to know the location of any Equipment installed on Vehicle.

4. Table 11-1.4 through 11-1.20 to know the references to IWD, SIWD, ECBS, ECBCL, P & PD and Maintenance Manuals of any Equipment not pertaining the COMMUNICATIONS and, for this reason, not presented in this Volume.

5. Para 11-1.22 for Coupler Pins Arrangement and Trainline Wire List.

It is recommended to put back in its own plastic envelope, after use, any Diagrams/Schematics with the “Page number” readable.
Each plastic envelope is provided with the same Page # of the Drawing/Schematic that it contains, in order to have all Drawing/Schematics always in right position for future use.

11-1.5 Applicability

This Integrated Wiring Diagrams Manual is applicable to the SAN FRANCISCO MUNI LRV2 (Vehicles # 1400 through 1476) manufactured by BREDA COSTRUZIONI FERROVIARIE S.p.A.
Whenever a system, subsystem, assembly or component is applicable to a particular vehicle configuration only, (i.e. Prototype Vehicles # 1400, 1401, 1403, 1449) its applicability is clearly indicated in a specific NOTE field in the relevant section/para/sheet where the specific system, subsystem, assembly or component is presented.

11-1.6 Updating

The content of this Integrated Wiring Diagrams Manual (Vol M04 – J) is subject to be updated as a result of modification to the vehicle configuration.
Discrepancies should be reported to Manufacturer using the Discrepancy Report form attached at the end of this section, to be mailed to:

ANSALDOBREDA COSTRUZIONI FERROVIARIE S.p.A.
Via Ciliegiole 110/b
51100 PISTOIA (ITALY)

11-1.7 Acquisition of Copies, Revisions and Changes

Copies of this Volume of the Integrated Wiring Diagrams Manual Set and related changes/revisions may be obtained by applying to:

ANSALDOBREDA COSTRUZIONI FERROVIARIE S.p.A.
Via Ciliegiole 110/b
51100 PISTOIA (ITALY)

11-1.8 Technical Publications Discrepancy Report

SUBSCRIBER: IF YOU BELIEVE THAT YOU HAVE DISCOVERED A DISCREPANCY IN A BREDA TECHNICAL PUBLICATION, PLEASE COMPLETELY IDENTIFY THE PUBLICATION, DESCRIBE THE DISCREPANCY OR DEFICIENCY IN DETAIL AND FORWARD THIS COPY TO BREDA.

(PUBLICATION No (s) (IF APPLICABLE).....

(PUBLICATION TITLE (s).....

EDITION OF REVISION DATE.....AFFECTED PAGE No (s) .....
AMENDMENT OR CHANGE DATE.....AFFECTED FIGURE No (s).....

NAME.....ADDRESS .....
.....
.....

SIGNATURE.....
..... AFTER COMPLETING FORM, MAIL COPY TO:

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Via Ciliegiole 110/b
51100 PISTOIA (ITALY)

DISCREPANCY/DEFICIENCY (Describe discrepancy by text and/or sketch)

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11-1.9 General Safety Precautions

Three categories of precautionary notes are utilized in this publication. The precautionary notes in this publication are meant as a guide to indicate those most serious areas of potential hazard. Normal safety operating and maintenance procedures for working with HVAC supply, LVDC supply and high pressure pneumatic components must be observed at all times. The precautionary notes are utilized throughout this publication as follows:

WARNING: **INDICATES AN OPERATION, SEQUENCE OR FUNCTION WHICH, IF NOT OBSERVED, MAY CAUSE LOSS OF OR SERIOUS DAMAGE OR INJURY TO PERSONNEL OR EQUIPMENT AND/OR MAY CAUSE A CRITICALLY UNSAFE CONDITION ON THE VEHICLE. STRICTLY ADHERE TO ALL WARNING NOTES.**

CAUTION: INDICATES AN OPERATION, SEQUENCE, OR FUNCTION WHICH IF NOT OBSERVED MAY CAUSE DAMAGE OR MALFUNCTION OF EQUIPMENT AND/OR MAY CAUSE A NON-CRITICAL MALFUNCTION ON THE VEHICLE.

NOTE: Provides explanatory information/clarification of procedures which are not readily apparent in the text or illustrations.

Ensure that you are thoroughly familiar with the instructions for a component and are familiar with all precautionary notes prior to attempting a sequence of operations or maintenance. Failure to follow procedures and precautionary notes in this publication could cause loss of or serious injury to personnel and/or malfunction or damage to equipment.

A list of general precautions is outlined herein. For additional safety precautions related to specific maintenance task refer to para **Specific Safety Precautions**. Reference is made to SAN FRANCISCO MUNI LRV2 Standard Procedures for specific Authority requirements. Refer to para 11-1.10 for Hazard Areas.

WARNING: **IT IS THE RESPONSIBILITY OF EVERY EMPLOYEE TO ASSIST IN THE DETECTION AND REPORTING OF UNSAFE CONDITIONS.**

ALL HAZARDS OR POTENTIAL HAZARDS MUST BE REPORTED TO YOUR IMMEDIATE SUPERVISOR AND/OR ELIMINATED AS SOON AS POSSIBLE.

ALL CIRCUITS, PARTS AND WIRING NOT KNOWN TO BE "DEAD" SHOULD BE CONSIDERED "LIVE" AT ALL TIMES.

(Cont'd)

WARNING: **PERSONNEL SHOULD NOT CARRY METAL RULERS, METALLIC-CASED FLASHLIGHTS, METALLIC PENCILS, OR KEYS WHEN PERFORMING ON-CAR MAINTENANCE.**

EQUIPMENT SHOULD BE GROUNDED. PERSONNEL SERVICING OR PERFORMING MAINTENANCE ON THE EQUIPMENT SHOULD TAKE PRECAUTIONS AGAINST ACCIDENTAL GROUNDING AND SHOULD USE ONLY ONE HAND DURING TESTING AND SERVICING TASKS.

DE-ENERGIZE ALL COMPONENTS BEFORE MAKING HAND CONTACT, ESPECIALLY WHEN BRUSHES ARE SHIFTED, RAISED OR INSPECTED.

ALWAYS USE TEST EQUIPMENT KNOWN AND GUARANTEED TO BE IN GOOD OPERATING CONDITION. ADHERE TO ALL VOLTAGE AND CURRENT VALUES. USE CORRECT METER RANGES WHEN TAKING MEASUREMENTS.

ALWAYS SHUT OFF ELECTRICAL POWER TO EQUIPMENT BEFORE REMOVING, TESTING, SERVICING OR PERFORMING MAINTENANCE TASKS UNLESS THE TEST BEING PERFORMED REQUIRES THE APPLICATION OF POWER.

IN CASE OF FIRE:

WATER SHOULD BE USED ON FIBROUS MATERIALS SUCH AS PAPER, TEXTILES, ETC. WATER MUST NOT BE USED WHERE LIVE ELECTRICAL EQUIPMENT IS INVOLVED.

DRY POWDER EXTINGUISHERS SHOULD BE USED AGAINST FIRE IN SOLIDS, LIQUID AND GASEOUS MATERIALS THAT BURN WITHOUT SMOLDERING SUCH AS PETROL, OIL, PARAFFIN, ETC. SINCE THE POWDER JET IS NON - CONDUCTIVE, THE EXTINGUISHER MAY BE USED IN ELECTRICAL INSTALLATIONS. THE POWDER MAY BE USED TO DAMPEN FIRES IN WOOD AND TEXTILES, BUT DEEP SEATED FIRES DEMAND WATER FOR FINAL CONTROL.

(Cont'd)

WARNING: **CARBON DIOXIDE (CO_2) FUNCTIONS AS AN EXTINGUISHING AGENT MAINLY DUE TO THE CHOKING EFFECT OF THE HEAVY GAS THAT EXPELS THE AIR. IT IS SUITABLE IN LIQUID FIRES, AND PARTICULARLY SUITED AGAINST FIRES IN ELECTRICAL INSTALLATIONS AND MOTORS SINCE CARBON DIOXIDE IS NON - CONDUCTIVE AND LEAVES NO TRACES AFTER USE.**

TO OBTAIN A GOOD RESULT, THE QUANTITY OF CARBON DIOXIDE MUST EXCEED THAT OF THE AIR. THIS IS OBTAINED BY SWIFTLY MOVING THE NOZZLE FROM SIDE TO SIDE.

FIRST AID:

MOUTH-TO-MOUTH METHOD OF ARTIFICIAL RESPIRATION ("KISS OF LIFE").

THE METHOD MAY BE USED AT ANY TIME, ANYWHERE, AND DOES NOT REQUIRE ANY APPARATUS.

METHOD:

A) PLACE THE INJURED PERSON ON HIS BACK (THE MOST CONVENIENT WAY OF GIVING ARTIFICIAL RESPIRATION).

B) BEND THE PATIENT'S HEAD BACKWARDS AS FAR AS IT WILL GO, WITH THE CHIN UPWARDS. THIS IS OFTEN ENOUGH FOR THE PATIENT TO START BREATHING BY HIMSELF.

C) EXAMINE THE PATIENT'S MOUTH AND THROAT AND REMOVE ANY MUCUS, ETC. USING YOUR INDEX FINGER.

D) IF THE PATIENT IS WEARING DENTURES, REMOVE THEM.

E) PINCH THE PATIENT'S NOSE.

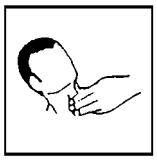
F) START INFLATION, CHECKING THAT THE PATIENT'S CHEST RISES AS LUNGS FILL WITH AIR.

G) DEFLATION (TAKES PLACE AUTOMATI-CALLY DUE TO THE ELASTICITY OF THE THORAX AND LUNGS).

H) 12 - 16 INFLATIONS PER MINUTE.

(Cont'd)

WARNING: **EXTERNAL HEART MASSAGE:**

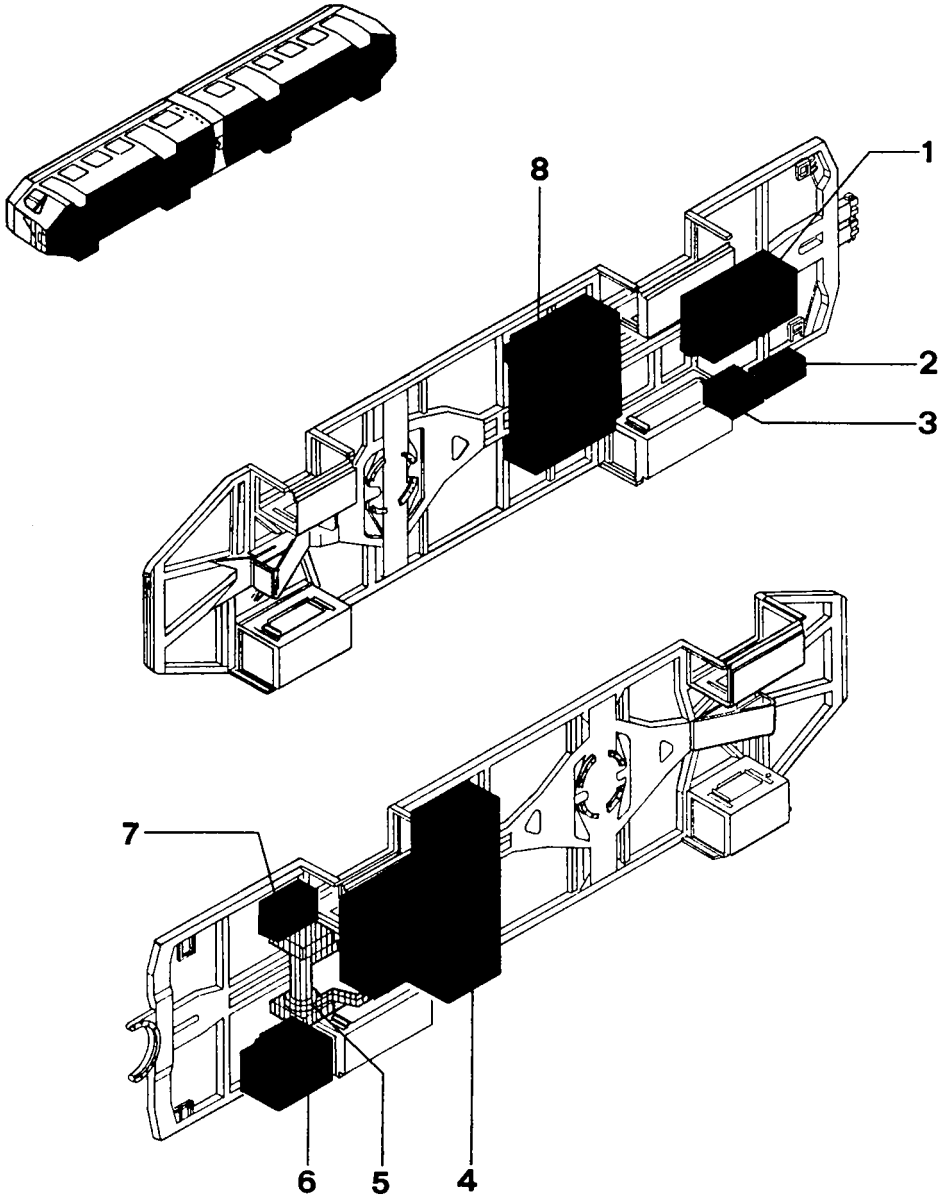


THE PATIENT IS PLACED ON HIS BACK ON A FIRM SURFACE, E.G. THE FLOOR OR THE GROUND. THE LIFE-SAVER THEN PLACES THE PALM OF ONE HAND OVER THE LOWER THIRD OF THE BREASTBONE. WITH THE OTHER HAND PLACED OVER THE BACK OF THE FIRST HAND, DOWNWARD PRESSURE IS APPLIED TO THE PATIENT'S BREASTBONE AT LEAST ONCE A SECOND.

AFTER EACH DOWNWARD PRESS, THE PRESSURE IS RELEASED TO ALLOW THE THORAX TO EXPAND COMPLETELY. THE LIFE SAVER PLACES HIS BODY SO THAT THE PRESSURE IS EXERTED BY HIS OWN BODY WEIGHT.

11-1.10 Hazard Areas

In the following illustrations are shown the vehicle's Hazard Area.
Hazard Area are identified by Max. voltage; inferior voltage may also be present.

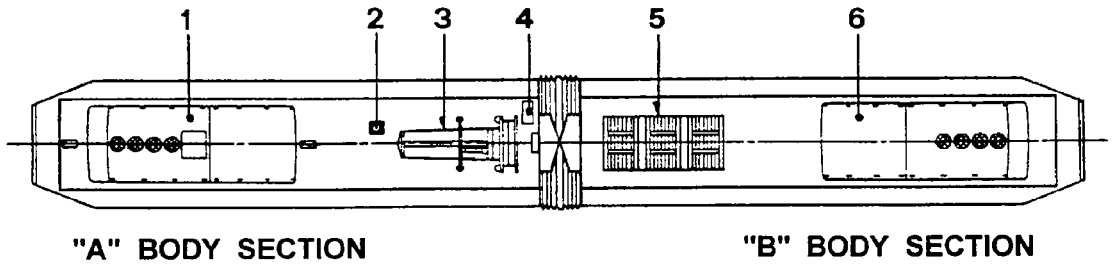


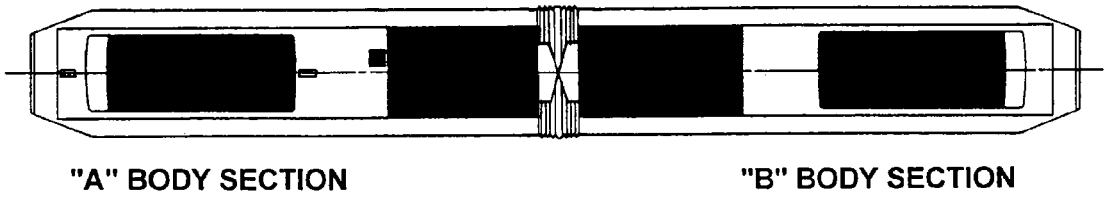
600 VDC

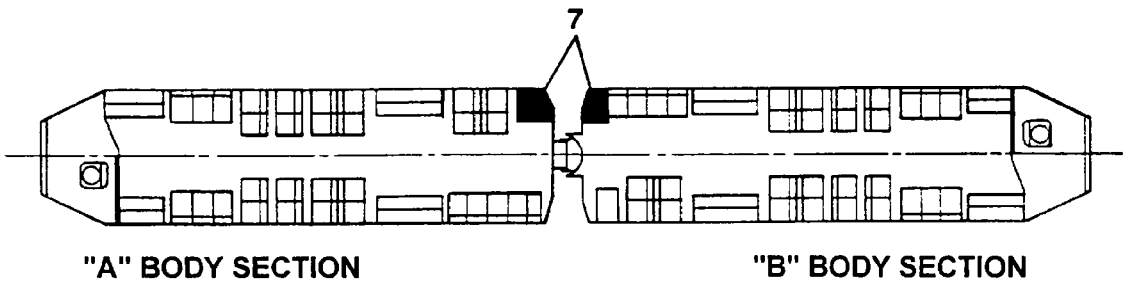
208 VAC

1. Air Supply Unit
2. Knife Switch
3. High Voltage Fuses Box
4. Propulsion Inverter
5. Inverter Blower
6. Line Breaker
7. Line Filter Reactor
8. Auxiliary Inverter

Figure 11-1.1 Hazard Areas – Underframe







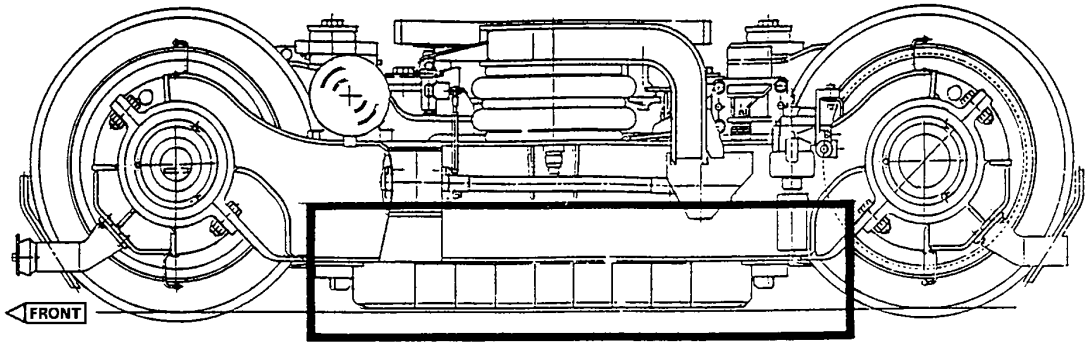
600 VDC

208 VAC

1. Climate Control Unit (HVAC)
2. Lighting Arrestor
3. Pantograph Assembly
4. Main Line Fuse
5. Brake Resistor
6. Climate Control Unit (HVAC)
7. Articulation Section Cabinets

Figure 11-1.2 Hazard Areas - Roof and Interior

MOTOR TRUCK



TRAILER TRUCK

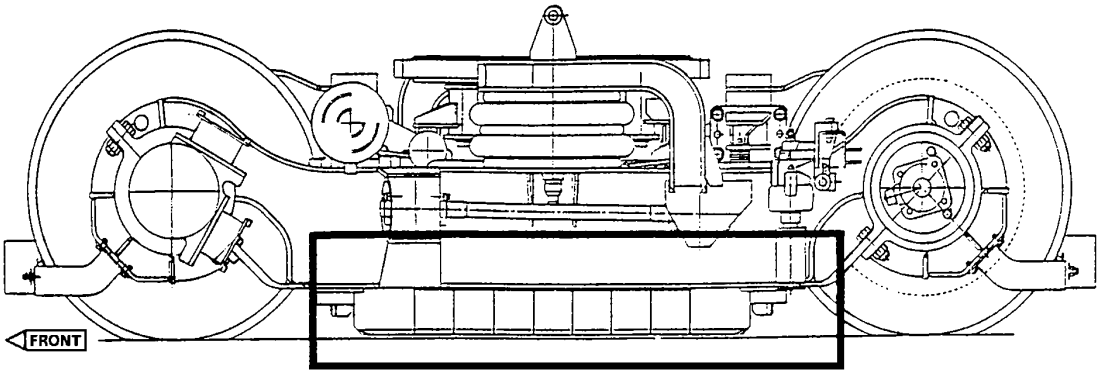


Figure 11-1.3 Hazard Areas - Track Brakes

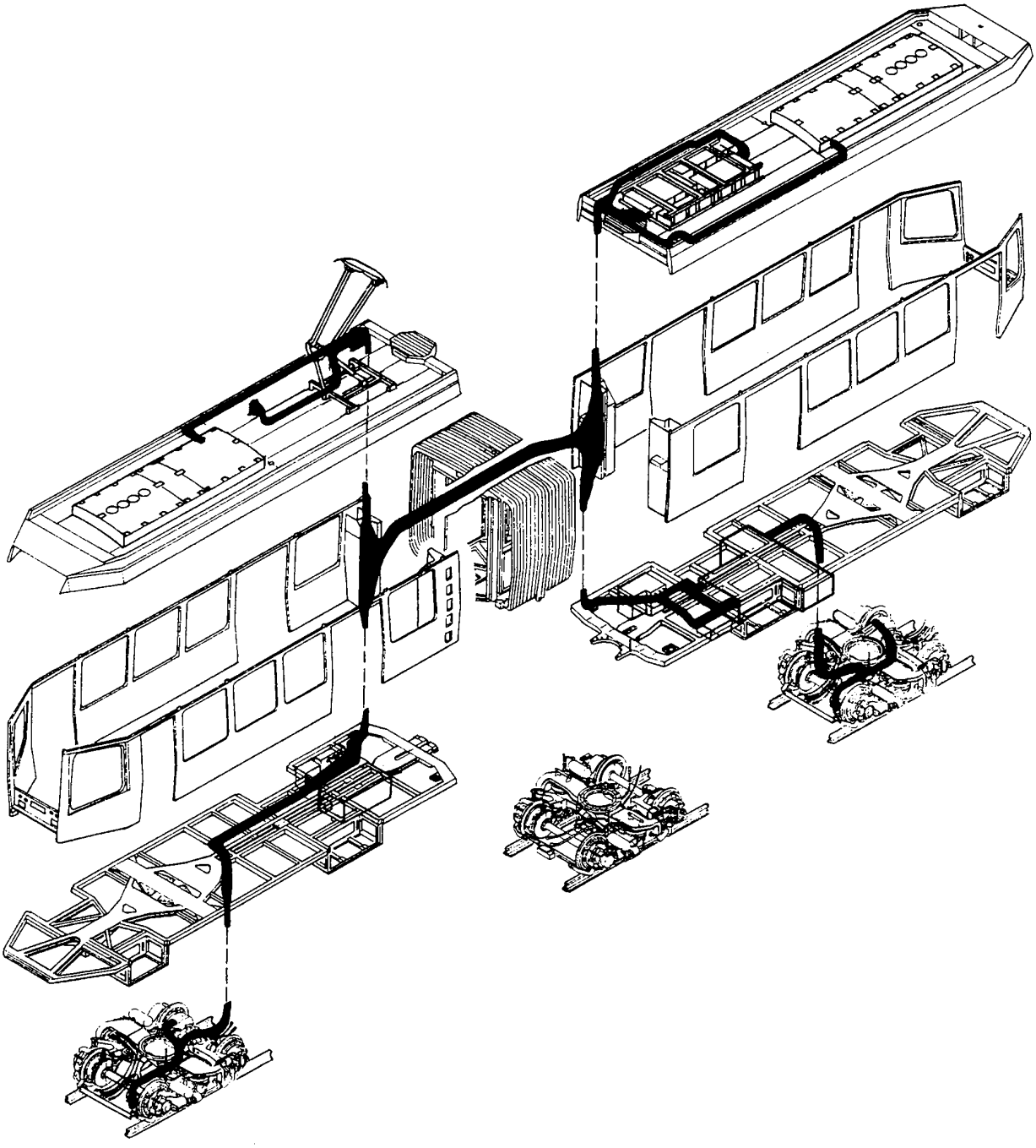


Figure 11-1.4 Hazard Areas - High Voltage Electrical Distribution

11-1.11 HV-LV Power Distribution

11-1.11.1 High Voltage System (refer to fig. 11-1.5)

The overhead line supplies 600 VDC to the LRV2 HV System through the Pantograph and a Lightning Arrestor to protect the vehicle systems from line surges. The High Voltage (600 VDC) is fed through the Main Line Fuse, Knife Switch and the underframe High Voltage Fuse Panels for overcurrent protection to the following subsystems:
- AIR COMFORT SYSTEM (Heating Coils)
- AIR SUPPLY SYSTEM (Air Compressor)
- PROPULSION SYSTEM (Traction Motors)
- AUXILIARY SYSTEM (Auxiliary Power Group)

The vehicle is equipped with a Shop Power receptacle to accept 600 VDC, through the Knife Switch, and in turn feeds the subsystem listed above for maintenance activities. When the 600 VDC is connected through the Shop Power Receptacle the Vehicle Propulsion System is deactivated and interlocked for safety reasons.

Input (High Voltage) power is applied to the Intermediate Voltage Power Supply (IVPS) which converts the 600 VDC to 350 VDC. The 350 VDC supplies input power to the Auxiliary Inverter and to the Low Voltage Power Supply (LVPS) (refer to fig.11-1.6 sheets1). The Auxiliary Inverter converts 350 VDC to 230 VAC (three phase).

The 230 VAC supplies power to the following equipment:
- Propulsion Motor Blowers
- Auxiliary Power Group Blower
- AC Dead Battery Start (ACDBS)
- Isolation (Step-Down) Transformer XT1.

The ACDBS converts the 230 VAC input to 37.5 VDC used in the event the battery is dead or below the normal operating specifications.
The 208 VAC output from XT1 supplies the following AC loads through the Circuit Breaker Box (refer to fig. 11-1.6 sheet 2/2)
- HVAC Loads
- Interior Lights
- Cab Heater
- Electrical Outlets.

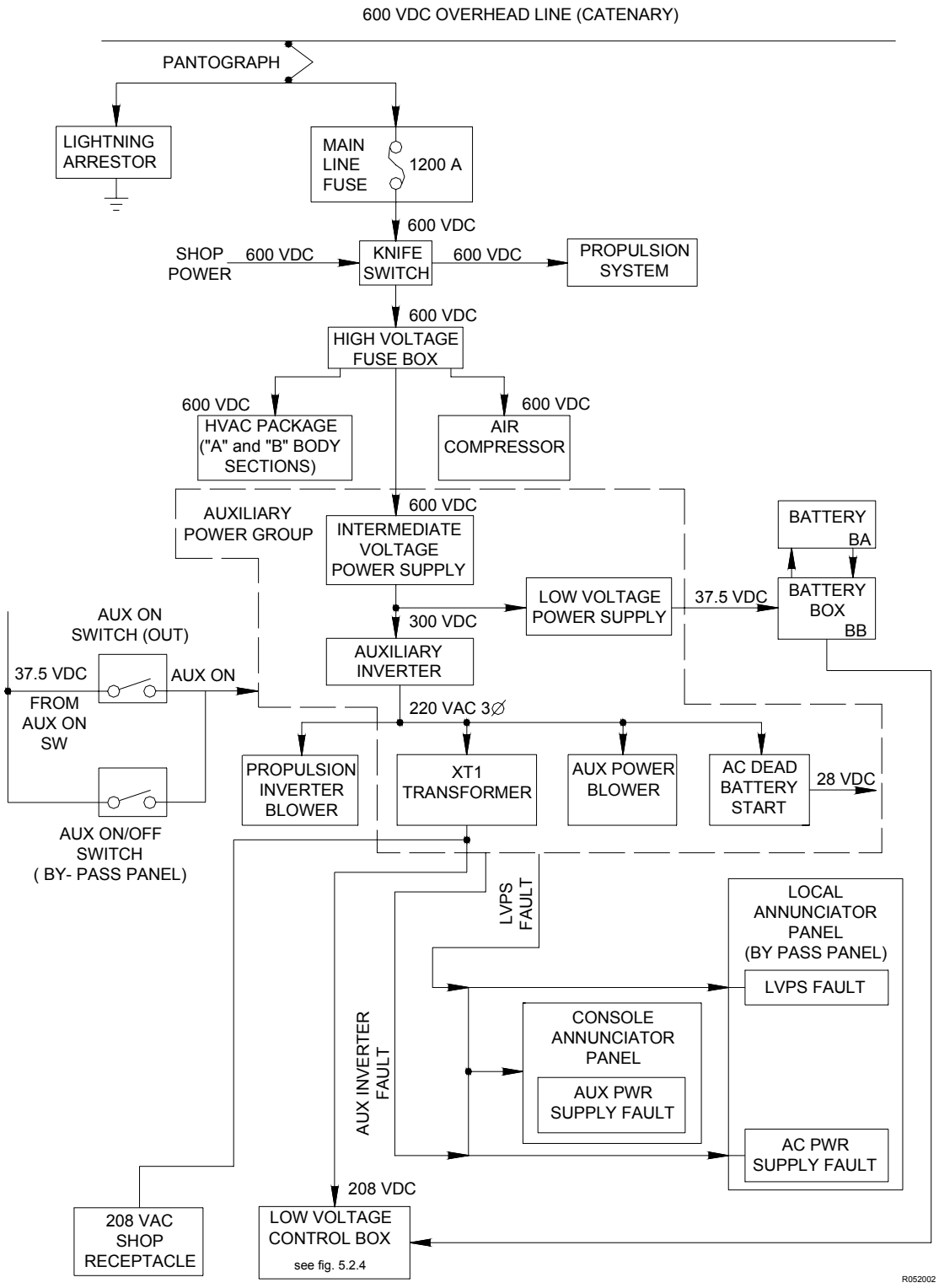


Figure 11-1.5 High Voltage DC/AC Power Distribution - Functional Diagram

11-1.11.2 Low Voltage System

The High Voltage Circuits (refer to fig. 11-1.6 sheet 1) supply input power to the Low Voltage Power Supply (LVPS). The LVPS supplies the required current to charge the Battery System and operate the auxiliary relays, and control subsystems.
The 350 VDC input to the LVPS is converted into 37.5 VDC and distributed as described below.
When the LVPS is inoperative the Battery supplies 37.5 VDC power to the Train System Bus, the Track Brakes and the Emergency Lights.
A circuit breaker automatically disconnects the battery if the voltage goes below 25 VDC or the battery temperature exceeds +131 °F (+55 °C).
The low voltage DC loads of the vehicle, operating under the LVPS, are divided into three bus systems as follows:

- SYSTEM BUS
- AUXILIARY BUS
- CAB BUS

All the loads (refer to fig. 11-1.6) are protected by fuses and circuit breakers inside the Low Voltage Control Box (Auxiliary Box) and the Low Voltage Circuit Breakers Panels.

a) The loads operating under the System Bus are the following:

- Door Actuator Left
- Door Actuator Right
- Interior & Emergency
- Lights Control
- Door Control
- Emergency Brake Train Line
- Auxiliary On
- Marker Lights
- Head & Tail Lights
- Stop Lights
- Radio
- Turn lights
- ATCS #3 PSU
- Aux Control

An independent line supplies 37.5 VDC power to door actuators and through the track brake contactor FU inside the Low Voltage Control Box, to Track Brake Actuator ("A", "B", "C").

b) The loads operating under the Auxiliary Bus and powered through the RAM contactor are listed below:

- Vetag
- Fare Box
- Passenger Request Control and Light
- HVAC Control
- Track Brake Control
- T/L Control # 2
- Pantograph Control
- Pantograph Actuator
- Air Compressor Control
- Coupler Control
- Step Control
- ATCS # 2 VOBC
- ATCS # 1 DU
- T/L Control # 1
- Sander Control
- Propulsion Control
- Destination Sign Control
- Friction Brake Control

c) The loads operating under the Cab Bus, powered through the RAM contactor, are listed below:

- Miscellaneous
- Console Lights
- Cab Blower
- Master Control
- Electrical Horn & Gong
- Destination Sign and Cab Spot

Emergency lights are energized through the RCL contactor and CB63 and CB64.

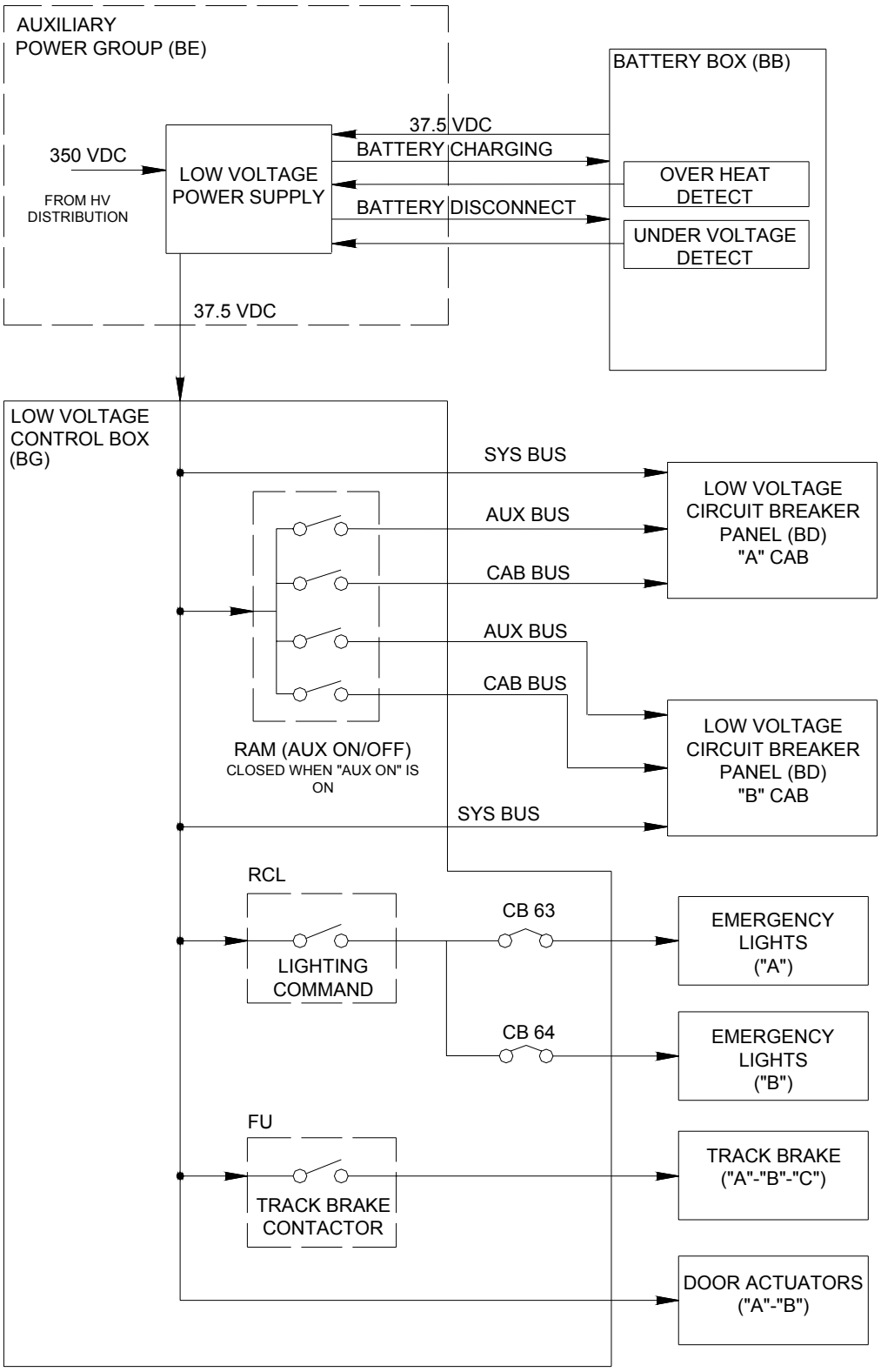
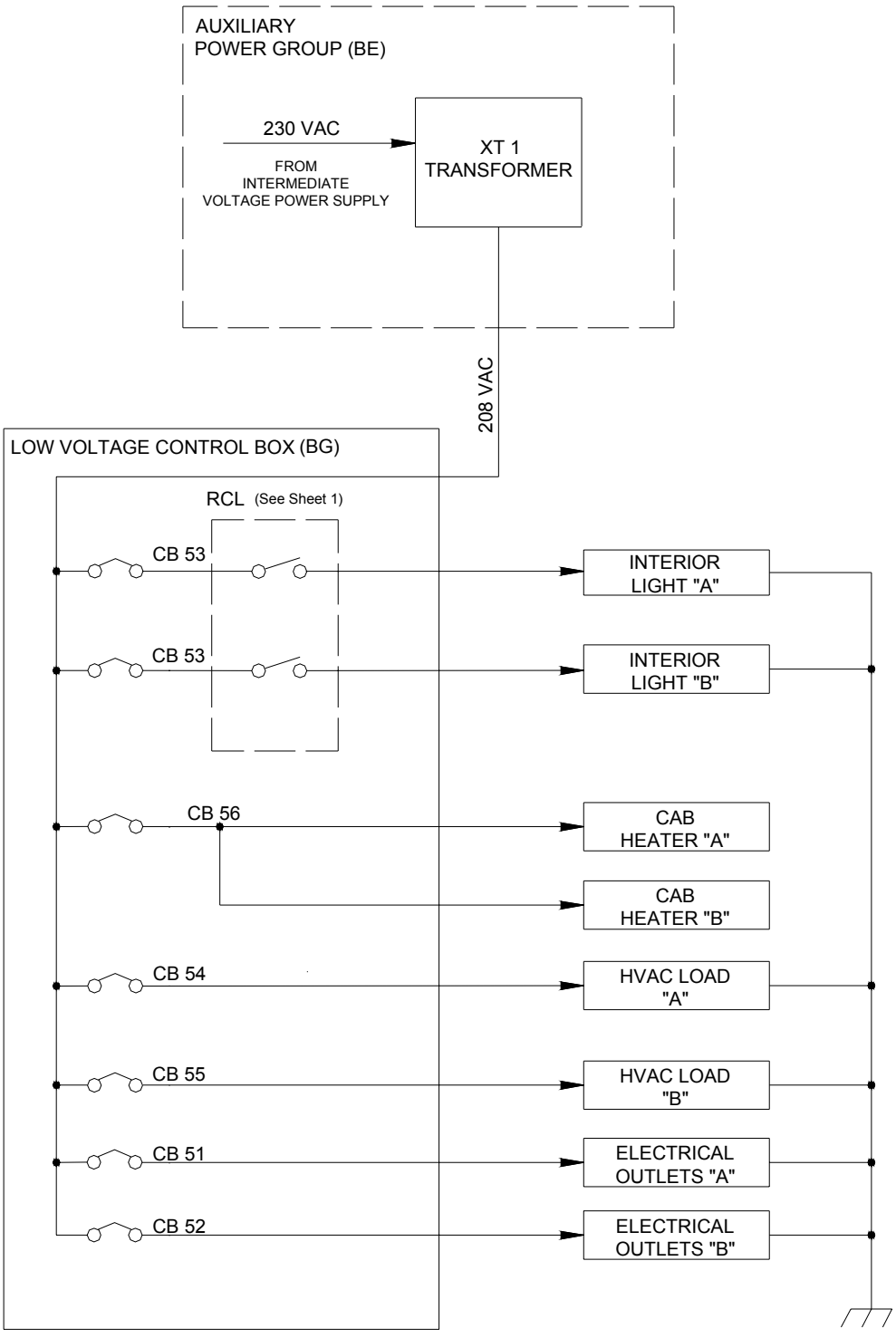


Figure 11-1.6 Low Voltage DC/AC Power Distribution - Functional Diagram (sheet 1 of 2)



AC - POWER DISTRIBUTION

Figure 11-1.6 Low Voltage DC/AC Power Distribution - Functional Diagram (sheet 2 of 2)

11-1.12 Component Identification

11-1.12.1 Wire Identification

- **High Voltage Wire Identification**

  The wires involved in the HV distribution are identified in the following manner:

  Ex. **X##** where **X** identifies one of the following:

  T represents High Voltage wires (600 VDC)
  R represents Negative Return wires (connected to Ground Plates MH)
  G represents Ground wires (from Ground Plate to Ground Brush MU and from Ground Plate to Shop Plug)
  ## represent wire numbers from 01 to 35 and identify a specific wire connection.

- **Low Voltage Wire Identification**

  LV wires are classified and identified as follows:

  - **Positive Battery Wires**

    Are identified as PB and connect both the Battery (+) to TBP1 and TBP2 and FU (track brake contactor) to track brake;
    The wire designation is the following:

    PB#(-x) or **PB##(-x)**

    where **#** identifies a specific connection and **x**, when present, refers to a single wire segment .

  - **Bus Systems Wires**

    The low voltage DC loads of the vehicle (see fig 11-1.6), are divided into three bus systems as follows:

    - SYSTEM BUS
    - AUXILIARY BUS
    - CAB BUS

    The pertinent wires are identified as follows:

    S#(-x) or **S##(-x)** for SYSTEM BUS
    X#(-x) or **X##(-x)** for AUXILIARY BUS
    C#(-x) or **C##(-x)** for CAB BUS

    where **#** identifies a specific connection and **x**, when present, refers to a single wire segment.

- **AC Loads Wires**

The AC load wires are identified as follows:

70XX-x wire phase R
71XX-x wire phase S
72XX-x wire phase T
73XX-x neutral

The **XX** two letter designation starts from AA in which the first letter refers to a specific circuit and the second letter changes whenever the wire passes through a component and the voltage changes. As mentioned before the **x** refers to a single wire segment.

- **Control Circuits Wires**

Control Circuits wires are those wires that pertain to the Control Circuits listed in Table 11-1.1.
The Control Circuit wires are identified as follows:

NNXX-x

Where the **NN** is the Control Circuit identification Number (refer to Table 11-1.1) and **XX** is a two letter group that refers to a specific circuit. The double letter designation may have any letter combination starting from AA. Recall the second letter in the **XX** designation changes upon a wire entering and exiting through a component and the voltage of the wire may change. The designation **x** refers to a single wire segment.

- **Negative Bus wires (NB)**

Negative bus wires are DC low voltage wires connected to Ground.
The Negative Bus wires are identified as follows:

NB#(-x) or **NB##(-x)**

Where the **#** identifies a specific connection and **x**, when present, refers to a single wire segment.

- **Electric Trainlines wires (ET)**

The Electric Trainlines wires carry trainline signals up to the coupler electrical contacts.
The wires are identified as follows:

ET###

The ET### wires connect the Trainline Junction Boxes, section A and B of the vehicle. The **###** indicates the trainline signal number (reference to Table 11-1.21).

ET###-x

The ET###-x designate the remaining ET wires in the vehicle; recall the **###** reference the trainline signal wire numbers (reference to Table 11-1.21) and **x** references a single wire segment.

Table 11-1.1 Low Voltage Wire Identification Numbers

WIRE No	CONTROL CIRCUIT
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	STEP CONTROL
15	
16	
17	DOOR CONTROL
18	DOOR CONTROL
19	
20	DOOR PROPULSION INTERLOCK
21	
22	
23	LIFT SYSTEM
24	
25	
26	CAB INTERLOCK
27	
28	PANTOGRAPH CONTROL
29	
30	
31	HEATING AND AIR CONDITIONING CONTROL
32	
33	
34	COMMUNICATION
35	
36	RADIO
37	WINDSHIELD CONTROL
38	
39	LOCK-OUT RELAY
40	37.5 VDC POWER CONTROL
41	LVPS CONTROL
42	
43	EMERGENCY RELAY
44	RELAY CONTROL
45	CAB AREA LIGHT
46	
47	PASSENGER COMPARTMENT LIGHT
48	EMERGENCY LIGHTS
49	DESTINATION SIGN

Table 11-1.1 Low Voltage Wire Identification Numbers (Cont'd)

WIRE No	CONTROL CIRCUIT
50	HORN CONTROL/GONG CONTROL
51	RUNNING LIGHTS
52	HEAD LIGHTS
53	TAIL LIGHTS
54	FRICTION BRAKE SYSTEM
55	FRICTION BRAKE SYSTEM
56	TRACK BRAKE SYSTEM
57	SANDING SYSTEM
58	
59	BRAKE APPLIED/RELEASED
60	
61	EMERGENCY BRAKE CONTROL
62	
63	HVAC LOADS
64	HVAC LOADS
65	HVAC LOADS
66	
67	OUTLETS
68	
69	
70	AC - SUPPLY X
71	AC - SUPPLY Y
72	AC - SUPPLY Z
73	AC - SUPPLY G
74	
75	COUPLER CONTROL
76	
77	
78	
79	
80	PROPULSION LOGIC
81	PROPULSION LOGIC
82	PROPULSION LOGIC
83	PROPULSION LOGIC
84	PROPULSION LOGIC
85	
86	
87	
88	ATCS CONTROL
89	ATCS CONTROL
90	
91	
92	
93	
94	
95	
96	
97	
98	
99	

- **Wire Gauge**

  Wire gauge on large high voltage cables is indicated by a combination letter and number system.

  MCM### or **AWG##** or **AWG#/#**

  The **MCM** and **AWG** are from the US wire size system. The **#** specifies the actual wire gauge number; the color code system used to reference AWG wire gauge is also provided.

Size (AWG)	Strand (No/Size)	Diameter (in.)	DC Resistance (68°F) (Ohms/1000 Ft.)	Nominal Weight (Lb/1000 Ft.)	Color
16	19/29	.062	4.82	7.43	pink
14	37/29	.076	2.24	14.5	green
12	37/27	.098	1.58	23.0	blue
10	27/24	.128	1.10	33.7	yellow
1/0	275/24	.440	.108	346	black
2/0	325/24	.477	.092	403	black
2/0	375/24	.520	.079	467	black
3/0	450/24	.565	.065	567	black
4/0	550/24	.620	.0543	684	black

  Shielded wires are black and white.

- **Wire Identification (wire on multiple schematics/sheets)**

  The fig. 11-1.7 is an example of the coding system that follows a wire from one schematic to another;

  NOTE: The first 2 digits and letter (B) indicate the drawing sheet number:

  Ex: 26B

  The second two letter and number designation (B8) indicates the Wire connection location on the sheet, using the alphanumeric grid scale provided on every drawing.

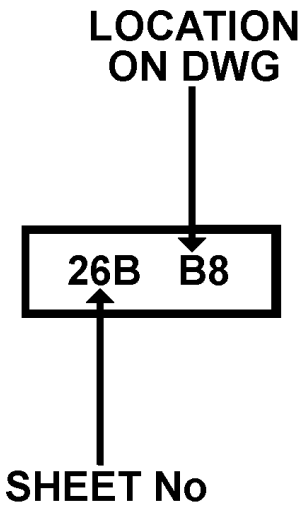


Figure 11-1.7 Wire Identification on Multiple Schematics/Sheets

11-1.12.2 Terminal Boards and Connectors Identification

Terminal boards in schematics are identified using an alphanumeric code system that includes the following information:

Refer to fig. 11-1.8 Terminal Board

-- FB identifies the equipment box or cabinet where the terminal board is located;

-- TB2 identifies the terminal board itself.

Connectors are identified using the same alphanumeric code that includes the following information:

Refer to fig. 11-1.8 Terminal Board

-- AC identify the equipment box or cabinet where the connector is contained or attached;

-- J3 identify the connector itself, where the letter "P" is used for plugs, and "J" is used for receptacles.

Within a connector, pins are identified by letters.

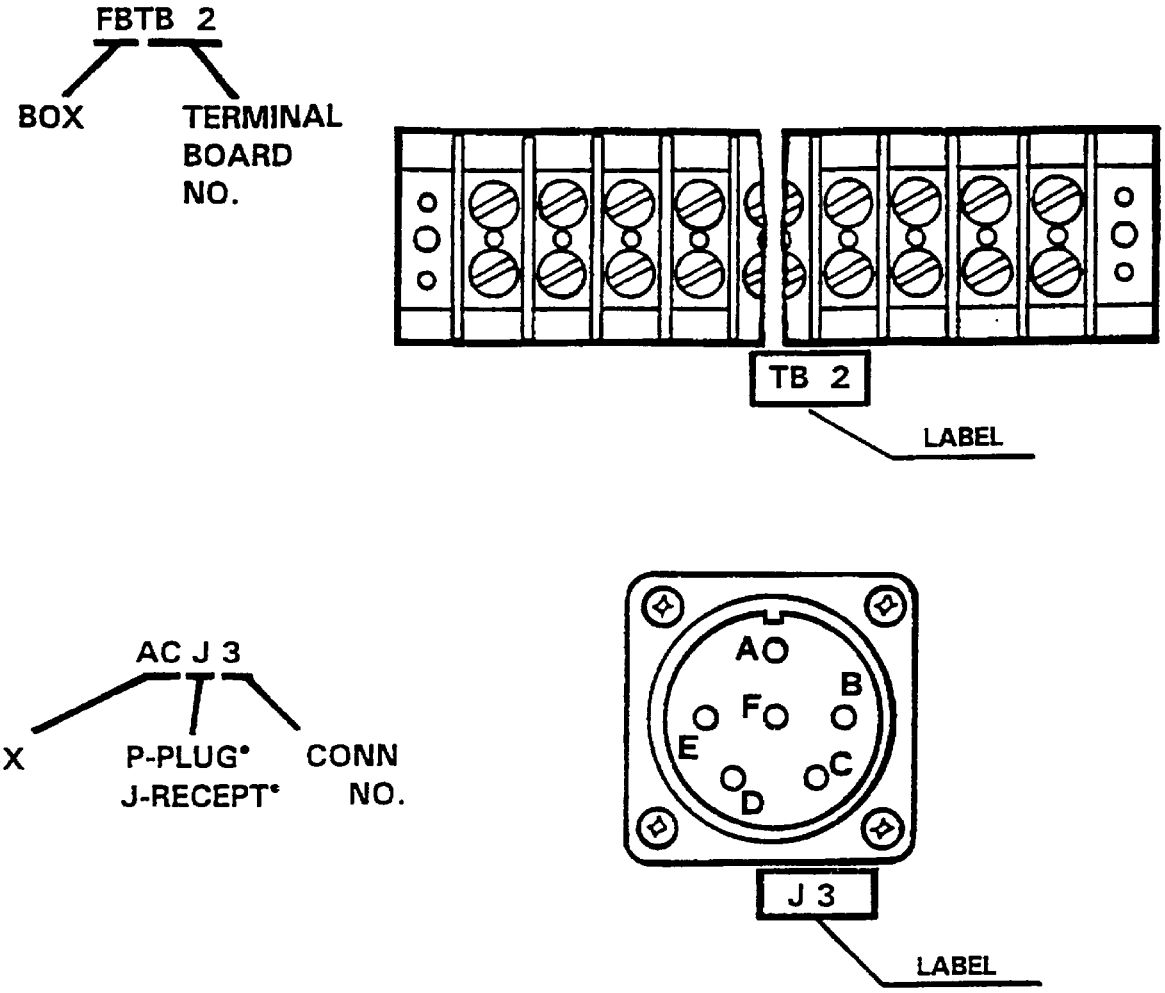


Figure 11-1.8 Terminal Boards, Connectors Identification - Typical Example

11-1.12.3 Terminal Blocks

Refer to Fig 11-1.9 Terminal Blocks Identification.
Terminal blocks are identified on schematics by a dashed line. The dashed line may connect two or more open bullets (small circles) which are the actual wire connection. The terminal connection are identified by two numbers separated by a dash (Ex.6-21). The number on the left of the dash indicates the terminal board number, the number on the right side refers to the connection block on the terminal board.

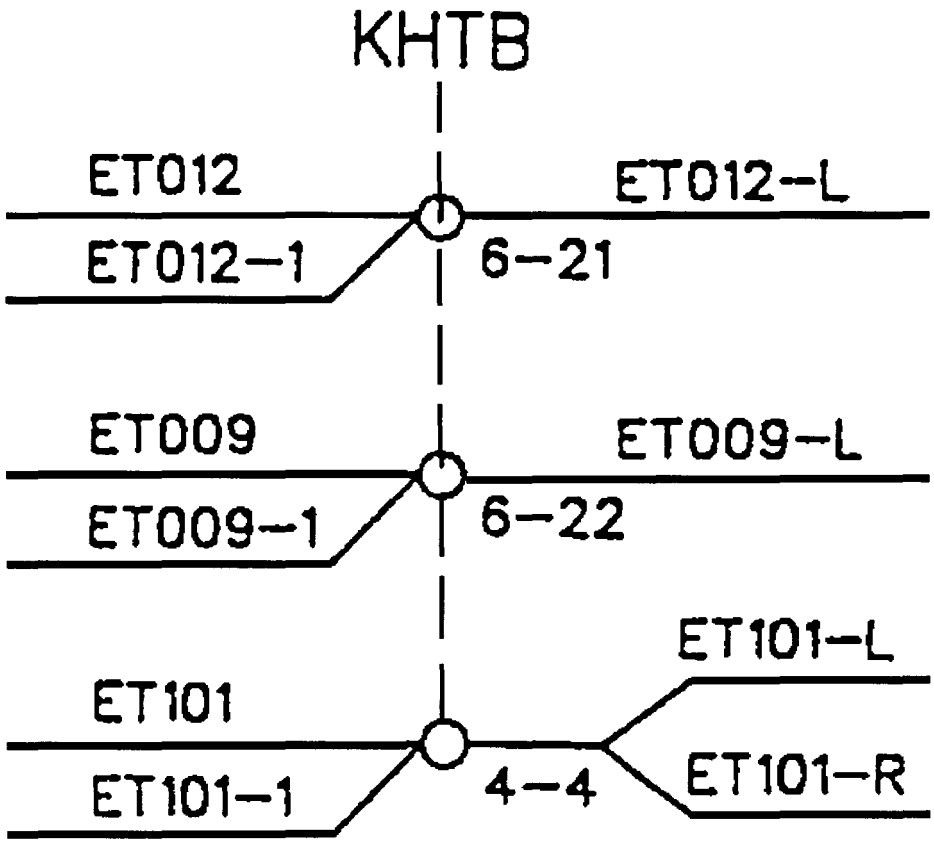


Figure 11-1.9 Terminal Blocks Identification

11-1.12.4 Symbols

All the electrical/electronic symbols used throughout the schematics are shown in the following Fig. 11-1.10 (Dwg 4.00.000 sheet 3).

INTENTIONALLY LEFT BLANK

MISCELLANEOUS

FUSE	RESISTORS				CAPACITOR		THERMOSTAT SWITCH		LIGHT		MOTOR					COMMUNICATION		
	TAPPED	ADJUSTABLE	FIXED		NON POLARIZED	POLARIZED	N. O.	N. C.	FLUORESCENT LAMP	INCADESCENT LAMP	FIELD	ARMATURE			DISCONNECTS	ANTENNA	SOUD POWERED PHONJACK	SPEAKERS

MISCELLANEOUS

PANTOGRAPH	LIGHTHING ARRESTOR		MAIN CIRCUIT BREAKER	KNIFE SWITCH	CONVENIENCE OUTLETS	EARTH BRUSH	GONG	REVERSER	THIRD RAIL SHOES	EXTERNAL CONE	HALL EFFECT CURRENT TRANSDUCER	AMMETER	BATTERY	MOTOR DISCONNECTOR	T/L REFERENCE	T/L REFERENCE	T. CONNECTION		

GENERAL CONTACTS

CONTACTOR RELAY & INTERLOCK						MICROSWITCH		REMOTE SWITC		CAM SWITCH		PUSH BUTTON						PUSH BUTTON DOUBLE BREAK	
N. O.	N. C.	N. O.	N. C.	N. O.	N. C.	N. O.	N. C.	N. O.	N. C.	N. O.	N. C.	MOMENTARY N. O.	MOMENTARY N. C.	MOMENTARY N. O.	MOMENTARY N. C.	MOMENTARY N. O.	MOMENTARY N. C.	MOMENTARY N. O.	MOMENTARY N. C.

GENERAL CONTACTS

PRESSURE SWITCH		TOGGLE SWITCHES							CIRCUIT BREAKER		THERMAL	TIME DELAY WHEN IS DE-ENERGIZED		TIME DELAY WHEN IS ENERGIZED	
C. WITH PRESSURE	O. WITH PRESSURE	N. O.	N. C.	1-0-2	0-1-2	MOMENTARY N. O.	MOMENTARY N. C	MOMENTARY 1-0-2	MAGNETIC SERIES TRIP	MAGNETIC SHUNT TRIP		N. O.	N. C.	N. O.	N. C.

GENERIC SUBSYSTEM

EQUIPMENT BOX PANEL

COILS

RELAY		MAGNET VALVES			REACTOR				TRACK BRAKE
CONTACTOR-RELAY	TIMING RELAY			DUPLEX VALVE	AIR CORE	IRON CORE	SATURABLE	SHUNT COIL	

SEMICONDUCTORS

DIODE	ZENER	THIRISTOR (SCR)	TRANSISTORS	
			NPN	PNP

CONDUCTORS

NOT CONNECTED	CONNECTED	CONNECTED TO		SHELDED CONTUCTORS				
		GROUND	CHASSIS					

CONNECTION

TERMINAL BCARD		PLUG N.		INTERCONNECTION	TEST POINT

LOGIC SYMBOLS

OP. AMPLIFIER	AND GATE	NAND GATE	OR GATE	NOR GATE	INVERTER	GENERAL	DELAY	SINGLE SHOOT	FLIP FLOP	CLOCK	LIGHT EMITTING DIODE	OPTCAL COUPLER	METAL OXIDE VARISTOR	ANALOGIC/LOGIC CONVERTER

DISEGNO VALIDO FINO AL VEICOLO 1476
VALID DRAWING UNTILL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	Kg. / Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

Fig. 11-1.10
ELECTRICAL / ELECTRONIC SYMBOLS

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROV APPRO
2	01/15/99	CABEL	LOMBARDI	
1	06/30/94	BONACCHI	MORONI	BALD
0	05/26/92	BONACCHI	MORONI	BALD

11-1.37

QUESTO DISEGNO E' ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COPIA LA RIPRODUZIONE E LA CESSIONE A TERZI A NORMA DI LEGGE.
THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORBIDDEN ACCORDING TO LAW.

SCALA / SCALE	QUANTITY P. VEICOLO / P.TRUCK P. CARRELLO / P.TRUCK	UGUAGLIANZE / EQUALITES	PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.	FOGLIO / SHEET
			SOSTITUISCE IL SUPERSEDED	3 DI OF 51

DESCRIZIONE / DESCRIPTION	ELECTRICAL SYSTEM	TIPO TYPE R07
BREDA COSTRUZIONI FERROVIARIE	GENERAL AND PARTIAL WIRING DIAGRAM	MATR. FILE 4.00.000
	GRAPHIC SIMBOL	DISEGNO DWG. N. 136787
	COMMESSA JOB 111B	CONTRACT N. #309

11-1.13 Equipment Identification Code (E.I.C.) and On Board Location Layout

The following Table 11-1.2 provides the Equipment Identification Code (EIC) of each Equipment installed on board of the LRV2 (Vehicles # 1400 through 1476).

The EIC are provided in alphabetical sequence.

The EIC listed in Table 11-1.2 are consistent with those listed in the RWI and in the IWT.

NOTE: In the RWI and IWT the EIC is/are followed by (A) or (B) to indicate the relevant "A" or "B" Body Section where the Equipment is installed.

In addition, Table 11-1.2 provides, for each specific equipment the relevant co-ordinates referred, respectively, to Fig. 11-1.11, 11-1.12 and 11-1.13 where the complete Equipment On Board Location Layout is presented.

Table 11-1.2 Equipment Identification Codes and On Board Location Layout

CODE	EQUIPMENT/UNIT	UNDERCAR LOC (Fig. 11-1.11))	INT & EXT. LOC (Fig. 11-1.12)	OVERHEAD LOC (Fig. 11-1.13)
AA	ATCS "VOBC"	--	H4	--
AB	ATCS ELECTRONIC UNIT "DU"	--	F1, H7	--
AC	OPERATOR CONSOLE	--	F7	--
AD	THUMBWHEEL SWITCH	--	F7	--
AE	ATCS P-WIRE GENERATOR	--	--	--
AM	ATCS RECEIVE ANTENNA	F4	--	--
AN	BOX ELECTRONIC UNIT "DCB"	--	F7	--
AP	ATCS POWER SUPPLY	--	H4	--
AQ	ATCS SPEED SENSOR	H4	--	--
AR	DIGITAL DISPLAY	--	F7	--
AT	ATCS TRANSMIT ANTENNA	F4	--	--
AV	ATCS ACCELEROMETER	--	H4	--
AW	ATCS TERMINAL BOARD PANEL	--	H4	--
BA	BATTERY BOX	H5	--	--
BB	BATTERY CIRCUIT BREAKER PANEL	H5	--	--
BD	LOW VOLTAGE CIRCUIT BREAKER PANEL	--	F7, H1	--
BE	LOW VOLTAGE POWER SUPPLY	E5	--	--
BG	AUXILIARY BOX	E4	--	--
BJ	PORTABLE BATTERIES CONNECTION	--	E7	--
BT	BATTERY THERMOSTAT	G5	--	--
CA	RADIO ANTENNA	--	--	D3, D4
CB	COMMUNICATION AMPLIFIER CONTROL UNIT	--	H7	--
CD	RADIO SILENT ALARM SWITCH	--	G7	--
CF	SIGNPOST RECEIVER	--	H7	--
CH	SPEAKER EXTERIOR	--	E2, H6	--
CI	INTERCOMMUNICATION UNIT PASSENGER AREA	--	E2, H6	--
CK	MOBILE DATA TERMINAL	--	F7, G1	--
CL	INTERIOR SPEAKERS	--	G5	--
CM	COMMUNICATION CONTROL UNIT	--	G7	--
CP	RADIO POWER SUPPLY	--	H7	--
CR	RADIO EQUIPMENT	--	H7	--

Table 11-1.2 Equipment Identification Codes and On Board Location Layout (cont'd)

CODE	EQUIPMENT/UNIT	UNDERCAR LOC (Fig. 11-1.11))	INT & EXT. LOC (Fig. 11-1.12)	OVERHEAD LOC (Fig. 11-1.13)
CS	GOOSENECK MICROPHONE	--	G1	--
CV	POWER LINE FILTER	--	H7	--
CW	TERMINAL BOARD PANEL	--	H7	--
DA	OBSTRUCTION ALARM	--	E7, F2, F3, F5, H1, H3, H5, H6	--
DF	INTERNAL PASSENGER PUSHBUTTON	--	E2, F3, F5, F6, G3, G5, H2, H3, H5, H6	--
DK	INTERNAL DOOR CREW SWITCH	--	F2, F4, G3, H6	--
DM	EXTERNAL DOOR CREW SWITCH	--	F2, F4, G6, H3	--
DN	PASSENGER EMERGENCY STOP	--	F3, G5	--
DO	DOOR OPERATOR	--	E2, E7, F3, F5, H1, H3, H5, H6	--
DP	PASSENGER EMERGENCY STOP RELEASE	--	E2, E7, F3, F5, H1, H3, H5, H6	--
DR	EXTERNAL PASSENGER PUSHBUTTON	--	E2, F3, F5, F6, G5, H2, H3, H5, H6	--
ET	UNCOUPLE SOLENOID VALVE CONNECTION	F1, G7	--	--
EX	ELECTRICAL COUPLER	F7, G1	--	--
EY	ELECTRICAL T/L CONNECTION	--	--	C3
FA	AIR COMPRESSOR	G5	--	--
FB	AIR BRAKE CONTROL UNIT	E1, E3, E4	--	--
FC	BRAKE CYLINDER PRESSURE SWITCH	H5	--	--
FE	AUXILIARY PNEUMATIC EQUIPMENT	H5	--	--
FF	FRICTION B. C/O STATUS	E1, G7	--	--
FG	AUXILIARY PNEUMATIC EQUIPMENT	H3	--	--
FH	AUXILIARY PNEUMATIC EQUIPMENT	E3	--	--
FK	MAIN RESERVOIR PRESSURE SWITCH	E5	--	--
FL	AUXILIARY PNEUMATIC EQUIPMENT	E5	--	--
FM	WEIGHT DETECTOR	E3, E4	--	--
FN	BRAKE ELECTRONIC CONTROL UNIT	--	F4	--
FS	CUT OUT BRAKE VALVE	--	F7, H1, H4	--
FT	HORN MAGNET VALVE	E1, G7	--	--
FU	TRACK BRAKE CONTACTORS	E4	--	--
FV	TERMINAL BOARD PANEL	--	F4	--
FW	ATCS DESTINATION SIGN INTERFACE	--	H4	--
FX	AUXILIARY PNEUMATIC EQUIPMENT	G2	--	--
GA	ADA CHIME SPEAKER	--	F2, F5, F6, G2, G3, G5, H6	--
GC	ADA CHIME CENTRAL SYSTEM	--	F3, H4	--
GO	GONG	E1, H7	--	--
GU	ADA CHIME LOCAL UNIT	--	E2, E5, F3, F6, G2, G5, H3, H6	--
HC	HVAC PACKAGE	--	--	D2, D4
HQ	CAB HEATER	--	G7, F1	--
JB	TRUCK JUNCTION BOX	G2, G6	--	--
KB	TERMINAL BOARD PANEL	--	F7, H1	--
KD	HV FUSES PANEL	H5		--
KE	MAINTENANCE TELEPHONE JACK	E3, E5, E7, F2, G1	F2, F4, G6	C3, D2

Table 11-1.2 Equipment Identification Codes and On Board Location Layout (cont'd)

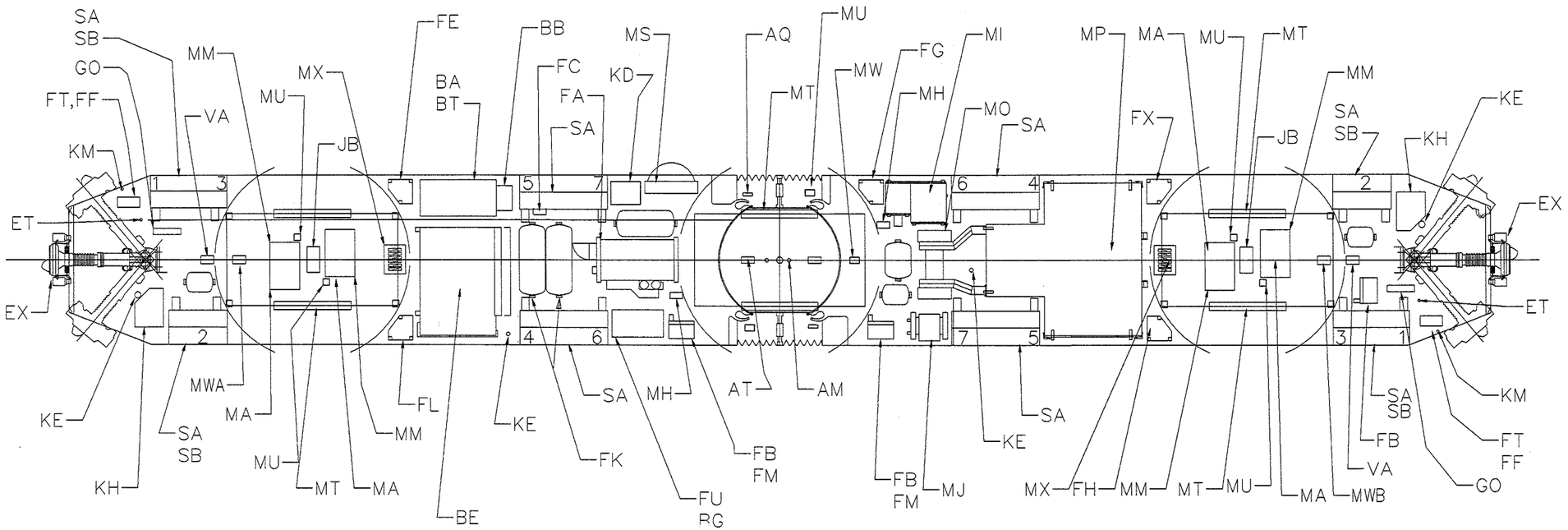
CODE	EQUIPMENT/UNIT	UNDERCAR LOC (Fig. 11-1.11))	INT & EXT. LOC (Fig. 11-1.12)	OVERHEAD LOC (Fig. 11-1.13)
KF	FRICTION BRAKE FAULT ANNUNCIATOR RELAYS PANEL	--	E4	--
KG	RUN NUMBER SIGN	--	G7	--
KH	TRAINLINE JUNCTION BOX	E7, G1	--	--
KM	AUXILIARY ON SWITCH	F1, G7	--	--
KO	CONVENIENCE OUTLETS	--	F4, G1, G4, G7	--
KQ	AUXILIARY RELAY PANEL 1	--	F7, H1	--
KR	AUXILIARY RELAY PANEL 2	--	E1, H7	--
KS	DESTINATION SIGN CONTROL UNIT	--	G7	--
KT	BY PASS SWITCH PANEL	--	F7, H1	--
KW	AUDIBLE ANNUNCIATION PANEL	--	F7, H1	--
KX	SIDE DESTINATION SIGN	--	F2, H6	--
KY	FRONT DESTINATION SIGN	--	G7	--
KZ	FARE BOX	--	G7	--
LA	CEILING LIGHT CIRCUIT "AC CIRCUIT"	--	F4, F5, F6, G5, G6	--
LB	TURN LIGHT	--	F1, F4, G1, H4	--
LC	DESTINATION SIGN LIGHT BALLAST	--	G6	--
LD	DOOR AREA LIGHT	--	G6	--
LE	CEILING LIGHT CIRCUIT "EMERGENCY"	--	F4, F5, F6, G4, G5, G6	--
LF	INTERIOR DOOR STATUS	--	E2, E3, F5, F6, H2, H3, H5, H6	--
LG	PASSENGER STOP REQUEST	--	F4, G2, G6	--
LH	HEAD LIGHT	--	F1, G1	--
LK	CAB SPOT LIGHT	--	F7	--
LL	RED MARKER LIGHT	--	F1, G1	--
LM	STEPWELL LIGHT	--	E6, F1, F2, F3, F5, G3, G5, H2, H3, H5, H7	--
LR	GREEN MARKER LIGHT	--	F1, G1	--
LS	EXTERNAL DOOR STATUS	--	E2, E3, F5, F6, G2, H3, H5, H6	--
LT	TAIL/STOP LIGHT	--	F1, G1	--
LU	"DOOR OUT OF SERVICE" EXTERIOR	--	E1, F3, F5, F6, H2, H3, H5, H6	--
LV	"DOOR OUT OF SERVICE" INTERIOR	--	E1, F3, H2, F5, F6, H3, H5, H6	--
LX	PUSH BAR LAMP	--	E1, F3, F6, H2, H3, H5, H6	--
LY	HEAD LIGHT RESISTOR PANEL	--	F7, H1	--
LZ	TROUBLE LIGHT	--	F2, F6, G6, H2	--
MA	TRACTION MOTOR	E2, E6, H2	--	--
MB	PANTOGRAPH	--	--	D3
MD	PROPULSION DIAGNOSTIC PANEL	--	F4	--
ME	MASTER CONTROLLER	--	F7, G1	--
MF	MAIN LINE FUSE	--	--	D3
MH	HIGH VOLTAGE GROUND PLATE	F4, G3	--	--
MI	LINE BREAKER	H3	--	--
MJ	LINE FILTER REACTOR	E3	--	--
MM	SPEED SENSORS	E2, E5, H2, H6	--	--
MN	LIGHTNING ARRESTOR	--	--	D3

Table 11-1.2 Equipment Identification Codes and On Board Location Layout (cont'd)

CODE	EQUIPMENT/UNIT	UNDERCAR LOC (Fig. 11-1.11))	INT & EXT. LOC (Fig. 11-1.12)	OVERHEAD LOC (Fig. 11-1.13)
MO	PROPULSION SYSTEM MOTOR BLOWER	G3	--	--
MP	POWER CONTROL EQUIPMENT (PCE)	H3	--	--
MQ	BRAKE RESISTOR	--	--	D2
MS	KNIFE SWITCH AND AUXILIARY FUSE	H4	--	--
MT	TRACK BRAKE	E2, E6, H2, H4	--	--
MU	GROUND BRUSH	E2, E6, G6, H2, H4	--	--
MW	ARTICULATION DERAIL SWITCH TRAILER TRUCK	H4	--	--
MWA	ARTICULATION DERAIL SWITCH TRUCK "A"	F6	--	--
MWB	ARTICULATION DERAIL SWITCH TRUCK "B"	E1	--	--
MX	TRUCK/CAR BODY CONNECTION	E3, H6	--	--
MXA	TRUCK/CAR BODY CONNECTION / A	--	--	--
NB	PULL CORD SWITCH	--	F3, F4, F5, G4, H2, H4, H5	--
ND	SANDER (FOOT SWITCH)	--	F7, G1	--
PA	ATCS DIGITAL VOICE ANNUNCIATION	--		--
RDO	ADDITIONAL FUNCTION PANEL	--	F6, H2	--
RLE1	LIGHT UNDER GAPS RELAY PANEL	--	F5, H3	--
SA	STEP MOVING EQUIPMENT	E3, E6, F1, G2, G3, G5, F5, H7	--	--
SB	STEP EXTENSION EQUIPMENT	E1, E6, G2, H7	--	--
SC	CUT OUT SWITCH PANEL	--	E2, E3, E7, F5, H1, H3, H5, H6	--
SD	STEP ALARM	--	F2, F3, E7, E5, H1, H3, H5, H6	--
SK	COUPLING SWITCH	--	--	--
SM	SWITCH RADIO	--	--	--
TA	VIDEO SURVEILLANCE SYSTEM (PROVISION)	--	F4	--
TC	VIDEOCAMERA (PROVISION)	--	F5, F7, G2, G6, H2, H4	--
TM1	MICROPHONE FOR VIDEO SURVEILLANCE (PROVISION)	--	G4	--
VA	TRANSPONDER	E1, G6	--	--
VE	CODE CONTROL BOX (VETAG)	--	F7	--
WA	WIPER MOTOR ELECTRONIC CONTROL	--	G7	--
WE	EXTERIOR MIRROR	--	F1, G7	--
WM	WASHER MOTOR PANEL	--	H7	--
WW	WIPER MOTOR	--	G7	--

" A SECTION "

" B SECTION "



DISEGNO VALIDO FINO AL VEICOLO 1476

VALID DRAWING UNTILL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

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TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
8	12/10/99	BONACCHI	LOMBARDI	ING. DAMI	DRAWING CONFORMED TO CFG-1174
7	01/15/99	CABEL	LOMBARDI	ING. DAMI	DRAWING CONFORMED TO CFG-1119
6	19/07/95	NESTI	MORONI	BANDINELLI	DRAWING CONFORMED TO CFG 792
5	07/06/94	BONACCHI	MORONI	BALDI	DRAWING CONFORMED TO PMP LMP-2561
4	06/02/94	CAMMARATA	MORONI	BALDI	UPDATED THE DRAWING PER PMP UTQ-147. CHANGED POSITION ITEM FC. ADDED NOTE *.
3	09/13/93	BONACCHI			
2	07/28/93	CALCAGNA			
1	03/16/93	GIANNINI			
0	02/28/92	BINDI	MORONI	BALDI	ISSUED

Fig. 11-1.11
UNDERCAR EQUIPMENT LAYOUT

11-1.43

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A LA QUALE NE VIETA [illegible] THE DRAWING IS B.C.F. 'S PROPERTY, THE COPY, REPRODUCTION AND DISTRIBUTION TO THIRD PARTIES ARE FORB[illegible]

SCALA / SCALE

QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITES

PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.

SOSTITUISCE IL SUPERSEDED

FOGLIO / SHEET 5 DI OF 51

DESCRIZIONE / DESCRIPTION ELECTRICAL SYSTEM

TIPO TYPE R07

BREDA COSTRUZIONI FERROVIARIE

GENERAL AND PARTIAL WIRING DIAGRAM

UNDERCAR EQUIPMENT LAYOUT

MATR. FILE 4.00.000

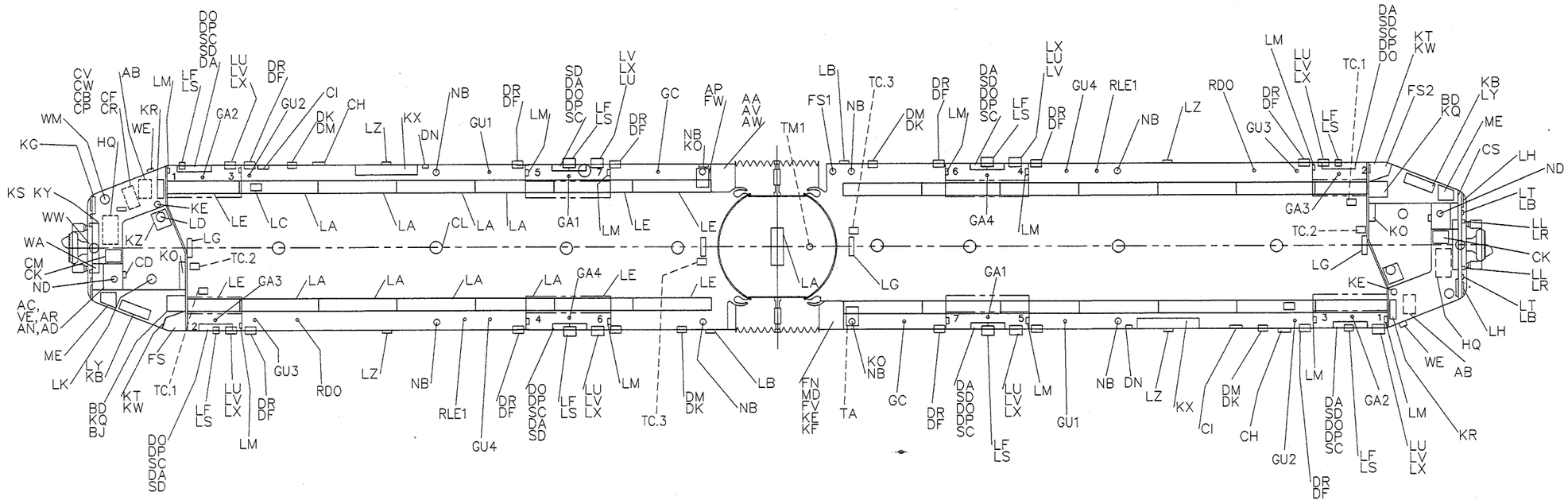
COMMESSA JOB 111B

CONTRACT N. #309

DISEGNO DWG. N. 136787

" A SECTION "

" B SECTION "



DISEGNO VALIDO FINO AL VEICOLO 1476
VALID DRAWING UNTIL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
7	12/27/99	BONACCHI	LOMBARDI	ING. DAMI	DRAWING CONFORMED TO CFG-1174 & 1139
6	01/15/99	CABEL	LOMBARDI	ING. DAMI	DRAWING CONFORMED TO CFG-1119
5	09/20/94	BONACCHI	MORONI	BALDI	ADDED CODE "KF" IN SECTION B. PMP UTQ-
4	06/30/94	BONACCHI	MORONI	BALDI	ADDED NOTA * PER PMP PMP-2561
3	07/28/93	CALCAGNA			
2	03/16/93	GIANNINI			
1	02/11/93	GIANNINI			
0	03/13/92	GIANNINI	MORONI	BALDI	ISSUED

Fig. 11-1.12
INT & EXT EQUIPMENT LAYOUT

11-1.45

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA COP
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SCALA / SCALE

QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITIES

PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.

SOSTITUISCE IL SUPERSEDED

FOGLIO / SHEET 6 DI OF 51

DESCRIZIONE / DESCRIPTION ELECTRICAL SYSTEM

BREDA COSTRUZIONI FERROVIARIE

GEN. & PART. WIRING DIAGRAMS
INT. & EXT.EQUIPMENT LAYOUT

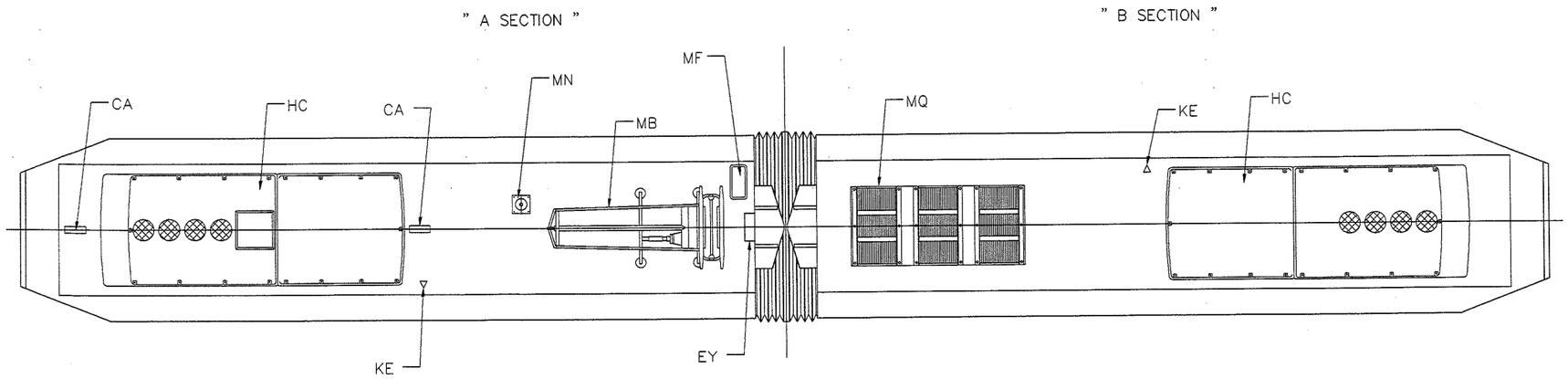
COMMESSA JOB 111B

CONTRACT N. #309

TIPO TYPE R07

MATR. FILE 4.00.000

DISEGNO DWG. N. 136787



DISEGNO VALIDO FINO AL VEICOLO 1476
VALID DRAWING UNTILL VEHICLE 1476

FILE	CODICE CODE	Q.TY REQD.	DENOMINAZIONE DESCRIPTION	DIMENS.UNIFIC.RIFERIM. SIZE STANDARDS REFERENCES	MATERIALE/NOTE MATERIAL/NOTES	KG. Lbs. UNITARY WEIGHT

DISEGNO ESEGUITO CON CAD : SONO VIETATE MODIFICHE O CORREZIONI MANUALI
DRAWING PROCESSED BY CAD EQUIPMENT : ANY MODIFICATIONS OR HAND WRITTEN CORRECTIONS ARE PROHIBITED

TOLLERANZE IN MANCANZA DI TOLLERANZE SPECIFICHE, SONO DA RITENERSI VALIDE QUELLE INDICATE NELLA TAB. 3610 DI NORMALIZZ.INTERNA E TAB. 8475 PER MANUFATTI DI PLASTICA. PER DIMENSIONI ANGOLARI VEDI TAB. UNI ISO 2768.
TOLERANCES UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE AS PER TAB. F.3610 OR 8475 (PLASTIC). TOLERANCES ON ANGULAR DIMENSIONS AS PER TAB. UNI ISO 2768.

REV. REV.	DATA DATE	DISEGNATO DRAWN	VERIFICATO CHECKED	APPROVATO APPROVED	
4	01/15/99	CABEL			
3	06/30/94	BONACCHI			
2	07/28/93	BONACCHI			
1	03/16/93	GIANNINI	MORONI	BALDI	UPDATED
0	02/25/92	GIANNINI	MORONI	BALDI	ISSUED

Fig. 11-1.13
OVERHEAD EQUIPMENT LAYOUT

11-1.47

QUESTO DISEGNO E' DI ESCLUSIVA PROPRIETA' DELLA BREDA COSTRUZIONI FERROVIARIE S.P.A. LA QUALE NE VIETA LA CO
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SCALA / SCALE

QUANTITA' QUANTITY: P. VEICOLO / P.VEHICLE; P. CARRELLO / P.TRUCK

UGUAGLIANZE / EQUALITES

PESO UNITARIO / UNITARY WEIGHT Kg. Lbs.

SOSTITUISCE IL SUPERSEDED

FOGLIO / SHEET 7 DI OF 51

DESCRIZIONE / DESCRIPTION: ELECTRICAL SYSTEM - GENERAL AND PARTIAL WIRING DIAGRAMS OVERHEAD EQUIPMENT LAYOUT

TIPO TYPE R07

MATR. FILE 4.00.000

DISEGNO DWG. N. 136787

BREDA COSTRUZIONI FERROVIARIE

COMMESSA JOB 111B

CONTRACT N. #309

11-1.14 Raceway and Wiring Identification (RWI) Tables

This para provides the Raceway and Wiring Identifications Tables for the whole LRV2 (Vehicles # 1400 through 1476).
The RWI Tables provides the following data:

- Raceway Location and Identification.
- Cable Types housed in each Raceway.
- Wire Identification.
- Wire Connection and relevant Equipment Identification Codes (E.I.C.).

In addition, for each Equipment, the RWI Tables provide the following references to IWD schematics collection:

- The IWD Sheet # where the Equipment/Subassembly and its relevant connections are represented.
- The IWD Page # of this Volume where the above IWD sheet is provided.
- The Equipment/Subassembly co-ordinates (Equip.Loc) on IWD sheet.
- The Subassembly to which the Equipment pertains.

The RWI Tables do not list the LVR2 Cable/Wires housed exterior of the raceways. The following lists the connections that are not listed in the RWI Tables:

- Electronic Board to Electronic Board Connections.
- Terminal Board to Terminal Board Connections.
- Terminal Board to Relay Connections.
- Subassembly Internal Wiring.

The RWI Tables provide the vehicle wiring data and are organized by the Raceway L.I. Code and ID number. It is recommended that the RWI tables be referred to after the faulty system is identified and the wiring data is needed. Following identification of the faulty system and the RWI wiring data, the IWT shall be referenced to determine the specifics of the equipment e.g., (from and to terminal board routing, PIN, references to the IWD).

Refer to para 11-1.14.3 “How to use the RWI Tables”.
For RWI Table content and layout details refer to para 11-1.14.2.
The RWI data are presented in numerical sequence by Location Illustration Code (L.I. Code) which meaning is detailed in the following para 11-1.14.1.

11-1.14.1 Raceway Locations Layout and Location Illustration Codes

The Raceway Location Layout is provided on one Illustration, which represents the entire Vehicle section and area plan. Each section/area is then subdivided into eight system specific illustrations representing a specific area on the vehicle. A universal "Location Illustration Code" (L.I. Code) is assigned to each of the 9 illustrations as follows:

L.I. CODE		VEHICLE SECTION/AREA
2-0	Raceway Location	Vehicle Section/Area Plan
2-1	Raceway Location	Roof
2-2	Raceway Location	"A" Body Section - RH Side
2-3	Raceway Location	"A" Body Section - LH Side
2-4	Raceway Location	"B" Body Section - RH Side
2-5	Raceway Location	"B" Body Section - LH Side
2-6	Raceway Location	"A" and "B" Body Sections - Art. Sect
2-7	Raceway Location	"A" Body Section – Underframe
2-8	Raceway Location	"B" Body Section - Underframe

The Figures 11-1.15 through 11-1.23 of para 11-1.14 provide the above Raceway Location Illustrations.
The L.I. Code is the universal link between the Raceway Location Illustrations presented in para 11-1.14.4 (related to the whole LRV2) and the Raceway Location Illustrations applicable to the COMMUNICATIONS presented in Section 11-3 para 11-3.5.1 (related to a specific System).

The L.I. Code is an universal code, it doesn't change within the volumes M 04-A through M 04-P of the IWD Manual.

11-1.14.2 Raceway and Wiring Identification Tables (RWI)– Format Content

Figure 11-1.14 shows the Raceway and Wiring Identification Table and Layout Format Layout.

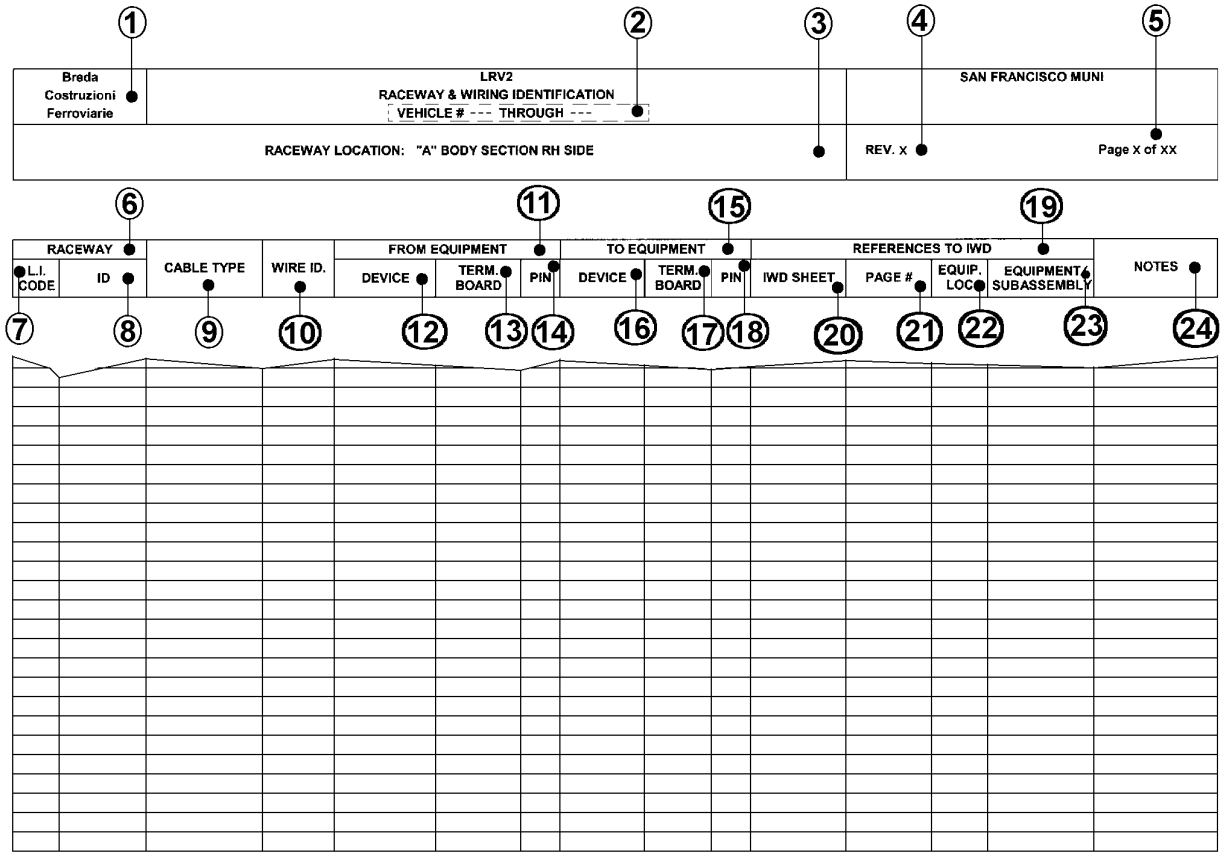


Figure 11-1.14 Raceway and Wiring Identification Table - Format

The Raceway and Wiring Identification Tables and corresponding field numbers are described as follows:

Field number/Title	Description
1) Breda Costruzioni Ferroviarie:	Name of LRV2 Builder.
2) VEHICLE # THROUGH #	Indicates the Vehicle # Range within the Raceway and Wiring Identification Tables are applicable.
3) VEHICLE SECTION/AREA:	Represents the name of Vehicle Section/Area and corresponding data listed in the RWI Tables.
4) REV #	Indicates the Revision # of the RWI Table.
5) PAGE X of XX:	In this field it is indicated the current page (X) and the total amount of pages (XX) of the RWI Tables pertaining to the Vehicle Section/Area indicated in the Field #3.
6) RACEWAY	Consists of two columns titled L.I. Code (7) and ID (8). They provide the Raceway Identification Code (on the vehicle) and the corresponding Location Illustration.
7) L.I. CODE	Indicates the universal Code assigned to each Raceway Location Illustration. Refer to para 11-1.14.1 for L.I. Codes List.
8) ID:	The ID field indicates the Identification Codes of the Raceways installed on the Vehicle.

The LRV2 Raceway installation scheme is identified as follows:

/ nn

where	**###**	is Raceway numerical designation.
where	**nn**	is Raceway External Diameter Identification (REDI) Code

The REDI Code “nn” is a two (numerical) digits code may vary from 01 to 10 to which it is associated the corresponding Raceway External Diameter as follows:

REDI Code	Raceway External Diameter (inches)	REDI Code	Raceway External Diameter (inches)
01	**0.51**	**06**	**1.77**
02	**0.67**	**07**	**2.36**
03	**0.86**	**08**	**2.95**
04	**1.10**	**09**	**3.15**
05	**1.41**	**10**	**3.93**

The Raceways with Identification Codes which do not follow the universal Coding are listed below with their relevant meanings.

	I.D. Code		Meaning
a)	605 [6]/09	605 =	Raceway numerical designation.
		[6] =	606 - Connector to 605 - Numerical designation.
		09 =	REDI Code.
b)	703/07/CRT	703 =	Raceway numerical designation.
		07 =	REDI Code.
		CRT =	Corrugated.
c)	703/b/CRT	703 =	Raceway numerical designation.
		b =	Additional.
		CRT =	Corrugated.
d)	###/!/nn	### =	Raceway numerical designation.
		! =	It may be "A" or "B" identifying the Vehicle Body Section where the Raceway is installed.
		nn =	REDI Code.
e)	###/CRT	### =	Raceway numerical designation.
		CRT =	Corrugated.
f)	CRT/nn	CRT =	Corrugated.
		nn =	REDI Code.
g)	CRT/nn - yy	CRT =	Corrugated.
		nn =	REDI Code.
		yy =	Numerical designation.

	I.D. Code (cont'd)		**Meaning (cont'd)**
h)	HVR/A HVR/B	HVR = A = B =	High Voltage Raceway. "A" Body Section. "B" Body Section.
i)	IVR/AL IVR/AR IVR/BL IVR/BR	IVR = A = B = L = R =	Intermediate Voltage Raceway. "A" Body Section. "B" Body Section. Left Side. Right Side.
j)	LVR/A LVR/AL1 LVR/AL2 LVR/AR1 LVR/AR2 LVR/B LVR/BL1 LVR/BL2 LVR/BR1 LVR/BR2	LVR = A = B = L = R = 1 = 2 =	Low Voltage Raceway. "A" Body Section. "B" Body Section. Left Side. Right Side. Raceway #1. Raceway #2.
k)	KZR/10	KZR = 10 =	Zinco Plated Raceway. REDI Code.
l)	KPS/08	KPS = 08 =	Glass Reinforced Plastic (square) Raceway. REDI Code.

9) CABLE TYPE: This field presents the Identification Code of the technical characteristics of the cable in accordance with (NFPA 70 and AAR S-538) requirements.
The symbol (*) indicates that the cable is supplied directly by the Supplier listed in the field # 24 NOTE.

10) WIRE ID: The Wire ID field indicates the Identification Code of the Wire. Refer to para 11-1.12.1 for details/clarifications.

11) FROM EQUIPMENT This field consists of three columns titled DEVICE (12), TERM BOARD (13) and PIN (14). which refer to the Equipment FROM Cable/Wire starting point.

12) DEVICE Lists the Identification Code of the Equipment/ Unit FROM the Cable/Wire starting point.

13) TERM BOARD:	Indicates the Identification Code of the Component FROM the related Cable/Wire starting point. The symbols "/" indicates that the corresponding field is left blank.
14) PIN	Indicates the Identification Code of the PIN Terminal Board FROM the related Cable starting point. The symbols "/" indicates that the corresponding field is left blank.
15) TO EQUIPMENT	Consists of three columns titled Device (16), TERM Board (17) and PIN (18). The reference point is TO the Cable/Wire arrival point.
16) DEVICE	Lists the Identification Code of the Equipment/Unit TO the Cable/Wire arrival point.
17) TERM BOARD	Indicates the identification Code of the Component inside the Unit TO the Cable/Wire arrival point. The symbols "/" indicates that the corresponding field is left blank.
18) PIN	The Pin field indicates the Identification Code of the PIN Terminal Board TO the Wire arrival point. The symbols "/" indicates that the corresponding field is left blank.
19) REFERENCES TO IWD:	This field consists of 4 columns titled IWD SHEET # (20), Page # (21) EQUIP.LOC (22) and SUBASSY (23).
20) IWD SHEET	Indicates the Sheet number of the IWD where the specific Equipment and its relevant connections, Cable type and Wire Identification are represented.
21) PAGE #	Indicates the Volume Page # where the IWD schematics listed in the field # 20 can be found.
22) EQUIP. LOC:	Indicates the Equipment/Subassembly (listed in column 23) co-ordinates on the IWD Sheet (listed in column 20) where it is represented.

23) EQUIPMENT / SUB ASSEMBLY:	Indicates the Equipment / Subassembly listed in Table 11-3.1 in correspondence with its E.I.C.. This field is the link with the above Table which provides SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARD DATA AND DIAGRAMS/ SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (For Details refer to para 11-1.21).
24) NOTE:	Provides additional information (i.e. Cable Type, supplier etc.).

11-1.14.3 How to use the RWI Tables

Because the Vehicle Section/Area sectionalizes the RWI Tables field by numerical order, the RWI Tables are useful while performing troubleshooting/maintenance activities only when the faulty area is identified.
Once identified, it is recommended that the RWI Tables be used, by means of the "REFERENCES TO IWD" data (refer to Fig 11-1.14 columns 20 through 23), in conjunction with the COMMUNICATIONS IWD schematics and relevant IWT Tables, to determine the relationship of the Wires and Cables. The IWT tables are provided (in section 11-3, para 11-3.5.2) in alphanumerical sequence by Equipment Identification Code (E.I.C.).

Using the RWI Tables it is possible to identify:

- every Raceway installed on board the Vehicle;
- every Cable/Wire housed in Raceways;
- the Equipment connected by the Cables/Wires housed in the Raceways.

To use the RWI Tables it is suggested to proceed as follows:

1)	Refer to	For
Table 11-1.2 (Page 11-1.39) -	Equipment Identification Codes and On Board Location Layout.	The list of the Equipment covered in the RWI Tables.
Para 11-1.14.2 (Page 11-1.51) -	Raceway and Wiring Identification Tables Format Content.	Format Content Detail.
Fig. 11-1.14 (Page 11-1.51) -	Raceway and Wiring Identification Tables Format.	Format Illustration.
Fig. 11-1.15 (Page 11-1.59) -	(L.I. CODE 2-0) LRV2 Raceway Location Vehicle Section/Area Illustration Plan.	The (Faulty) Vehicle Section/Area and corresponding Raceway Location Illustration Code (L.I. Code) identification and selection.

2) Select one of the Figs. 11-1.16 through 11-1.23 (Raceway Location Illustration Code 2-1 through 2-8) and follow the RWI Table per the L.I. Code.

3) Refer to "REFERENCES TO IWD" columns and, in conjunction with the previous selected L.I. CODE:
   - go to the page (indicated in the relevant field of the "PAGE #" column)in order to find the corresponding IWD sheet (indicated in the relevant field of the "IWD SHEET" column);
   - consult the selected IWD sheet to identify the Subassembly/Equipment (indicated in the relevant field of the "EQUIPMENT / SUBASSEMBLY" Column) by means of its co-ordinates (indicates in the relevant field of the "EQUIP: LOC" column°) and by means of the alphanumerical grid provided in each Schematic/Diagram.

4) Proceed with the Diagram consultation in order find the data/information to accurately troubleshoot the faulty Equipment/Assembly/System.

5) Pay attention to the reference to:
   - SIWD, indicated by an ✳ positioned near the specific Equipment to which the SIWD pertains and near the relevant NOTE containing the relevant (SIWD) Supplier File #;
   - IWT, provided, when applicable, in each Schematic Diagram in a dedicated area (above the IWD Manual page #).

6) Use the Fig 11-1.25, LRV2 Systems Functional Interfaces Matrix, to quickly determine the Functional Interfaces between LRV2 Systems in order to select only the needed IWD Manual Volumes to perform COMMUNICATIONS troubleshooting.

7) Use the Table 11-3.1 "SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARD DATA AND DIAGRAM/SCHEMATIC AN MAINTENANCE MANUAL CROSS REFERENCE" to quickly determine the relationships between each Equipment (involved in the Troubleshooting/Maintenance activities) and the IWD, SIWD, IWT, ECBS, ECBCL and P & PD.

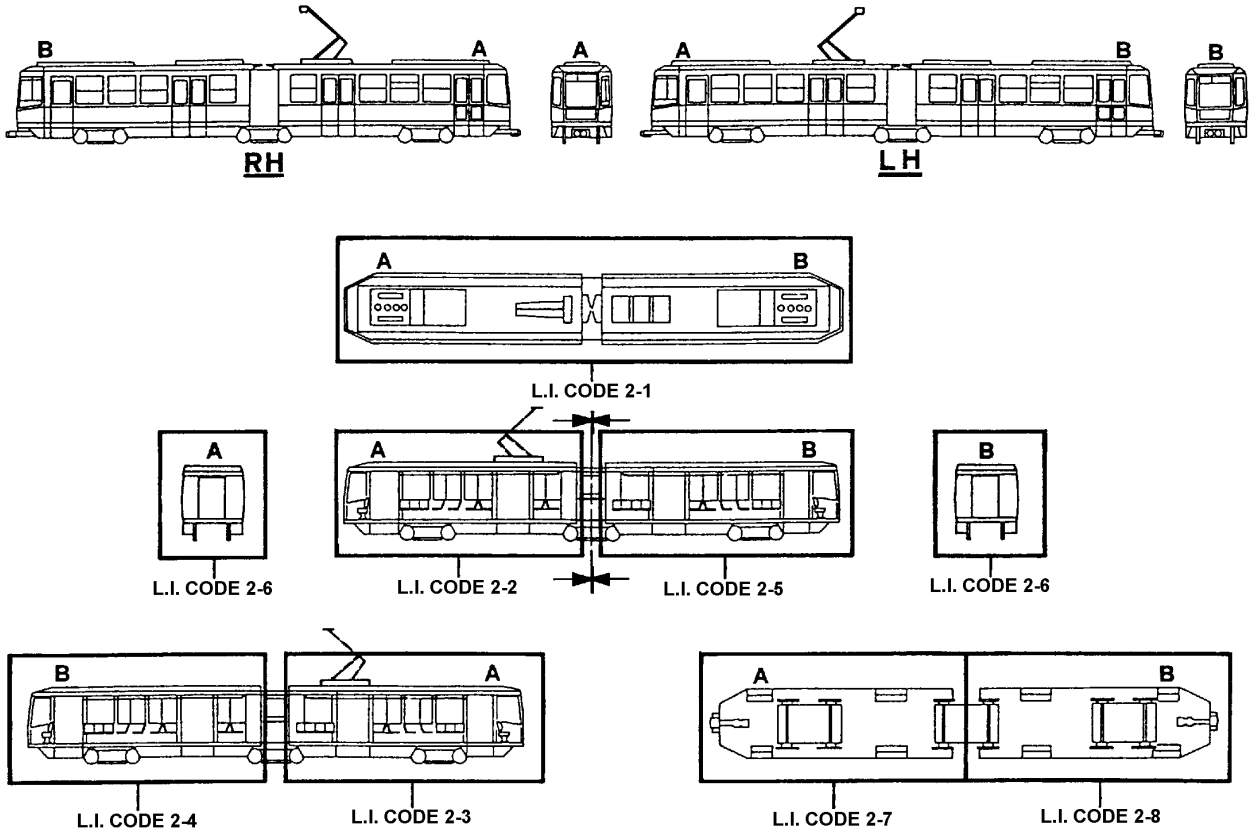
8) Use the Table 11-3.1 also to quickly know the relevant Para (s) of the RMSM, HRWM, and the relevant Sheet of the R-PMM and H-PMM where the needed Maintenance Procedures/Tasks can be found in details.

11-1.14.4 RWI Tables

The following pages make up the RWI Tables. The figures 11-1.15 through 11-1.23 of this para provide the Raceway Location Illustrations (L.I. Code 2-0 through 2-8).
The RWI Tables are provided in numerical sequence by L.I. CODE order as indicated in the following Table 11-1.3.

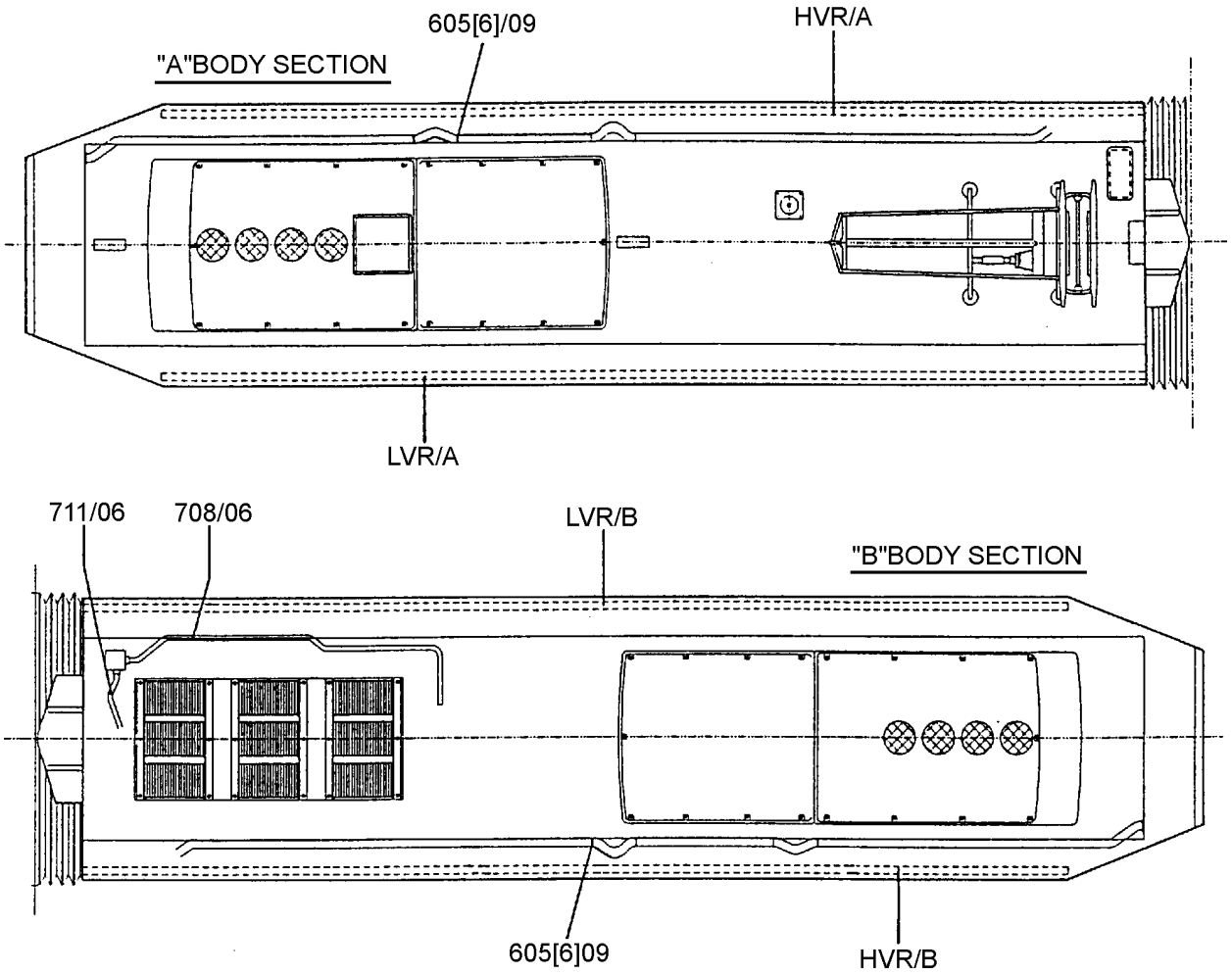
Table 11-1.3 RWI Tables – List

L.I. CODE	RACEWAY LOCATION	RWI TABLES	
		From Page	To Page
2-1	Roof	11-1.61	11-1.93
2-2	“A” Body Section RH Side	11-1.95	11-1.107
2-3	“A” Body Section LH Side	11-1.109	11-1.117
2-4	“B” Body Section RH Side	11-1.119	11-1.129
2-5	“B” Body Section LH Side	11-1.131	11-1.139
2-6	“A” and “B” Body Sections Art Sect Front	11-1.141	11-1.163
2-7	“A” Body Section – Underframe	11-1.165	11-1.175
2-8	“B” Body Section – Underframe	11-1.177	11-1.196



Location Illustration Code 2-0

Figure 11-1.15 LRV2 Raceway Location/Vehicle Areas – Illustration Plan



Location Illustration Code: 2-1

Figure 11-1.16 Raceway Location – Roof

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 1 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	16AWG	14EC-3	EYJ (B)	J10	29	KR (B)	TB2	9	22C	7-3.49	A5	ELECTRICAL T/L CONNECTION	SEE SH. 22A (PAGE 7-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	14EC-3	EYP (A)	P10	29	KR (A)	TB3	19					
2-1	605[6]/09	16AWG	34AB-2	EYP (A)	P10	6	CB (A)	J4	5	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	34AB-3	EYJ (B)	J10	6	CM (B)	P1	5					
2-1	605[6]/09	16AWG	34BB-2	EYP (A)	P10	7	CB (A)	J4	3					
2-1	605[6]/09	16AWG	34BB-3	EYJ (B)	J10	7	CM (B)	P1	3					
2-1	605[6]/09	16AWG	34CB-2	EYP (A)	P10	8	CB (A)	J4	14					
2-1	605[6]/09	16AWG	34CB-3	EYJ (B)	J10	8	CM (B)	P1	14					
2-1	605[6]/09	16AWG	34DB-2	EYP (A)	P10	9	CB (A)	J4	9					
2-1	605[6]/09	16AWG	34DB-3	EYJ (B)	J10	9	CM (B)	P1	9					
2-1	605[6]/09	16AWG	34EB-2	EYP (A)	P10	10	CB (A)	J4	16					
2-1	605[6]/09	16AWG	34EB-3	EYJ (B)	J10	10	CM (B)	P1	16					
2-1	605[6]/09	16AWG	34FB-2	EYP (A)	P10	11	CB (A)	J4	8					
2-1	605[6]/09	16AWG	34FB-3	EYJ (B)	J10	11	CM (B)	P1	8					
2-1	605[6]/09	16AWG	34GB-2	EYP (A)	P10	12	CB (A)	J4	10					
2-1	605[6]/09	16AWG	34GB-3	EYJ (B)	J10	12	CM (B)	P1	10					
2-1	605[6]/09	16AWG	34HB-2	EYP (A)	P10	13	CB (A)	J4	4					
2-1	605[6]/09	16AWG	34HB-3	EYJ (B)	J10	13	CM (B)	P1	4					
2-1	605[6]/09	16AWG	34JB-2	EYP (A)	P10	14	CB (A)	J4	7					
2-1	605[6]/09	16AWG	34JB-3	EYJ (B)	J10	14	CM (B)	P1	7					
2-1	605[6]/09	16AWG	34KB-2	EYP (A)	P10	17	CB (A)	J4	28	31A	7-3.89	D4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	34KB-3	EYJ (B)	J10	17	CM (B)	P1	28					
2-1	605[6]/09	16AWG	34LB-2	EYP (A)	P10	18	CB (A)	J4	33					
2-1	605[6]/09	16AWG	34LB-3	EYJ (B)	J10	18	CM (B)	P1	33					
2-1	605[6]/09	16AWG	34JB-3	EYJ (B)	J10	14	CM (B)	P1	7	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	16AWG	34KB-2	EYP (A)	P10	17	CB (A)	J4	28	31A	7-3.89	D4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	34KB-3	EYJ (B)	J10	17	CM (B)	P1	28					
2-1	605[6]/09	16AWG	34JB-3	EYJ (B)	J10	14	CM (B)	P1	7	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	34KB-2	EYP (A)	P10	17	CB (A)	J4	28	31A	7-3.89	D4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	34KB-3	EYJ (B)	J10	17	CM (B)	P1	28					
2-1	605[6]/09	16AWG	34LB-2	EYP (A)	P10	18	CB (A)	J4	33					
2-1	605[6]/09	16AWG	34LB-3	EYJ (B)	J10	18	CM (B)	P1	33					
2-1	605[6]/09	16AWG	34MB-2	EYP (A)	P10	19	CB (A)	J4	22					
2-1	605[6]/09	16AWG	34MB-3	EYJ (B)	J10	19	CM (B)	P1	22					
2-1	605[6]/09	16AWG	34NB-2	EYP (A)	P10	20	CB (A)	J4	6					
2-1	605[6]/09	16AWG	34NB-3	EYJ (B)	J10	20	CM (B)	P1	6					
2-1	605[6]/09	16AWG	34PB-2	EYP (A)	P10	21	CB (A)	J4	23					
2-1	605[6]/09	16AWG	34PB-3	EYJ (B)	J10	21	CM (B)	P1	23					
2-1	605[6]/09	16AWG/TH30	34QB-2	EYP (A)	P10	22	CB (A)	J4	29					
2-1	605[6]/09	16AWG/TH36	34QB-3	EYJ (B)	J10	22	CM (B)	P1	29					
2-1	605[6]/09	16AWG/TH30	34RB-2	EYP (A)	P10	23	CB (A)	J4	30					
2-1	605[6]/09	16AWG/TH36	34RB-3	EYJ (B)	J10	23	CM (B)	P1	30					
2-1	605[6]/09	16AWG	34SB-2	EYP (A)	P10	25	CB (A)	J4	37					
2-1	605[6]/09	16AWG	34SB-3	EYJ (B)	J10	25	CM (B)	P1	37					
2-1	605[6]/09	16AWG	34TB-2	EYP (A)	P10	26	CB (A)	J4	36					
2-1	605[6]/09	16AWG	34TB-3	EYJ (B)	J10	26	CM (B)	P1	36					
2-1	605[6]/09	16AWG	34WB-2	EYP (A)	P10	27	CB (A)	J4	1					
2-1	605[6]/09	16AWG	34WB-3	EYJ (B)	J10	27	CM (B)	P1	1					
2-1	605[6]/09	16AWG/TH40	35CA-10	EYJ (B)	J10	44	CL4 (B)	TB	2	31A	7-3.89	A4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG/TH40	35DA-10	EYJ (B)	J10	43	CL4 (B)	TB	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	16AWG	35GA-1	EYP (B)	P10	40	CW (A)	TB1	18	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	35GA-2	EYJ (B)	J10	40	CW (B)	TB3	9					
2-1	605[6]/09	16AWG	35HA-1	EYP (A)	P10	41	CB (A)	J2	27					
2-1	605[6]/09	16AWG	35HA-2	EYJ (B)	J10	41	CW (B)	TB3	10					
2-1	605[6]/09	16AWG	35RA-1	EYJ (B)	J10	30	KR (B)	TB6	1	31A	7-3.89	C4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	35RA-1	EYP (A)	P10	30	KR (A)	TB6	1					
2-1	605[6]/09	16AWG	35SA-1	EYJ (B)	J10	31	KR (B)	TB6	2					
2-1	605[6]/09	16AWG	35SA-1	EYP (A)	P10	31	KR (A)	TB6	2					
2-1	605[6]/09	16AWG	35TA-1	EYJ (B)	J10	49	KR (B)	TB6	3					
2-1	605[6]/09	16AWG	35TA-1	EYP (A)	P10	49	KR (A)	TB6	3					
2-1	605[6]/09	16AWG	35UA-1	EYJ (B)	J10	50	KR (B)	TB6	4					
2-1	605[6]/09	16AWG	35UA-1	EYP (A)	P10	50	KR (A)	TB6	4					
2-1	605[6]/09	16AWG	35VA-1	EYJ (B)	J10	51	KR (B)	TB6	5					
2-1	605[6]/09	16AWG	35VA-1	EYP (A)	P10	51	KR (A)	TB6	5					
2-1	605[6]/09	16AWG	35WA-1	EYJ (B)	J10	52	KR (B)	TB6	6					
2-1	605[6]/09	16AWG	35WA-1	EYP (A)	P10	52	KR (A)	TB6	6					
2-1	605[6]/09	16AWG	35XA-1	EYJ (B)	J10	53	KR (B)	TB6	7					
2-1	605[6]/09	16AWG	35XA-1	EYP (A)	P10	53	KR (A)	TB6	7					
2-1	605[6]/09	16AWG	35YA-1	EYJ (B)	J10	54	KR (B)	TB6	8					
2-1	605[6]/09	16AWG	35YA-1	EYP (A)	P10	54	KR (A)	TB6	8					
2-1	605[6]/09	16AWG	35ZA-1	EYJ (B)	J10	55	KR (B)	TB6	9					
2-1	605[6]/09	16AWG	35ZA-1	EYP (A)	P10	55	KR (A)	TB6	9					
2-1	605[6]/09	12AW/TH150	36BA-4	EYJ (B)	J10	59	KB (B)	TB5	12	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AW/TH150	36BA-4	EYP (A)	P10	59	KB (A)	TB5	12					
2-1	605[6]/09	16AWG/TH23	36CA-5	EYP (A)	P10	4	CW (A)	TB3	14	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG/TH34	36CA-6	EYJ (B)	J10	4	CM (B)	P1	31					
2-1	605[6]/09	16AWG/TH23	36DA-5	EYP (A)	P10	5	CW (A)	TB3	15					
2-1	605[6]/09	16AWG/TH34	36DA-6	EYJ (B)	J10	5	CM (B)	P1	32					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	16AWG/TH14	36GA-4	EYP (A)	P10	38	KR (A)	TB7	10	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG/TH38	36GA-5	EYJ (B)	J10	38	CW (B)	TB3	7					
2-1	605[6]/09	16AWG	36HA-2	EYP (A)	P10	33	KR (A)	TB7	2					
2-1	605[6]/09	16AWG	36HA-4	EYJ (B)	J10	33	CW (B)	TB3	2					
2-1	605[6]/09	16AWG	36JA-2	EYP (A)	P10	34	KR (A)	TB7	3					
2-1	605[6]/09	16AWG	36JA-4	EYJ (B)	J10	34	CW (B)	TB3	3					
2-1	605[6]/09	16AWG	36KA-2	EYP (A)	P10	35	KR (A)	TB7	4					
2-1	605[6]/09	16AWG	36KA-4	EYJ (B)	J10	35	CW (B)	TB3	4					
2-1	605[6]/09	16AWG	36LA-2	EYP (A)	P10	36	KR (A)	TB7	5					
2-1	605[6]/09	16AWG	36LA-4	EYJ (B)	J10	36	CW (B)	TB3	5					
2-1	605[6]/09	16AWG	36MA-2	EYP (A)	P10	37	KR (A)	TB7	6					
2-1	605[6]/09	16AWG	36MA-4	EYJ (B)	J10	37	CW (B)	TB3	6					
2-1	605[6]/09	16AWG	36NA-4	EYP (A)	P10	32	KR (A)	TB7	1					
2-1	605[6]/09	16AWG	36NA-6	EYJ (B)	J10	32	CW (B)	TB3	1					
2-1	605[6]/09	16AWG	36PA-1	EYJ (B)	J10	28	CW (B)	TB3	17					
2-1	605[6]/09	16AWG	36QA-2	EYP (A)	P10	1	CW (A)	TB3	16	31A	7-3.89	G4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	36RA-2	EYP (A)	P10	2	CW (A)	TB3	17					
2-1	605[6]/09	16AWG	36XA-1	EYJ (B)	J10	56	KR (B)	TB6	10	31A	7-3.89	C4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	16AWG	36XA-1	EYP (A)	P10	56	KR (A)	TB6	10					
2-1	605[6]/09	16AWG	36YA-1	EYJ (B)	J10	57	KR (B)	TB6	11					
2-1	605[6]/09	16AWG	36YA-1	EYP (A)	P10	57	KR (A)	TB6	11					
2-1	605[6]/09	12AWG/TH74	43AF-3	EYJ (B)	J7	20	AC (B)	A2-P1	24	29A	7-3.81	C5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG/TH74	43AF-3	EYP (A)	P7	20	AC (A)	A2-P1	24					
2-1	605[6]/09	12AWG/TH74	43AN-3	EYJ (B)	J7	34	AC (B)	A2-P1	23					
2-1	605[6]/09	12AWG/TH74	43AN-3	EYP (A)	P7	34	AC (A)	A2-P1	23					
2-1	605[6]/09	12AWG	ET018	EYJ (B)	J7	29	KB (B)	TB5	2	27C	7-3.73	D5	ELECTRICAL T/L CONNECTION	SEE SH. 27A (PAGE 7-3.69FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET018	EYP (A)	P7	29	KB (A)	TB5	2					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	12AWG	ET026	EYJ (B)	J7	6	KH (B)	TB2	1	44A	7-3.121	D5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET026	EYP (A)	P7	6	KB (A)	TB2	8					
2-1	605[6]/09	12AWG	ET028	EYJ (B)	J7	27	KH (B)	TB6	12	27D	7-3.75	D4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET028	EYP (A)	P7	28	KQ (A)	TB3	9					
2-1	605[6]/09	12AWG	ET029	EYJ (B)	J7	28	KH (B)	TB6	13					
2-1	605[6]/09	12AWG	ET029	EYP (A)	P7	27	KQ (A)	TB3	10					
2-1	605[6]/09	12AWG	ET033	EYJ (B)	J7	22	KB (B)	TB2	22	47A	7-3.129	C5	ELECTRICAL T/L CONNECTION	SEE SH. 47 (PAGE 7-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET033	EYP (A)	P7	22	KH (A)	TB2	8					
2-1	605[6]/09	12AWG	ET034	EYJ (B)	J7	21	KH (B)	TB2	7					
2-1	605[6]/09	12AWG	ET034-4	EYP (A)	P7	21	KQ (A)	TB5	12					
2-1	605[6]/09	12AWG	ET040	EYJ (B)	J7	8	KT (B)	TB1	20	38C	7-3.101	D6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET040	EYP (A)	P7	8	KT (A)	TB1	15					
2-1	605[6]/09	12AWG	ET041	EYJ (B)	J7	10	KR (B)	TB1	19					
2-1	605[6]/09	12AWG	ET041	EYP (A)	P7	10	KB (A)	TB1	8					
2-1	605[6]/09	12AWG	ET042	EYJ (B)	J7	4	KH (B)	TB3	20	43A	7-3.117	D4	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET042	EYP (A)	P7	4	KH (A)	TB3	20					
2-1	605[6]/09	12AWG	ET045	EYJ (B)	J7	12	KB (B)	TB5	15	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET045	EYP (A)	P7	12	KB (A)	TB5	15					
2-1	605[6]/09	12AWG/TH65	ET053	EYJ (B)	J7	18	KH (B)	TB5	14	29A	7-3.81	D5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG/TH65	ET053	EYP (A)	P7	18	KH (A)	TB5	14					
2-1	605[6]/09	12AWG/TH65	ET054	EYJ (B)	J7	17	KH (B)	TB5	15					
2-1	605[6]/09	12AWG/TH65	ET054	EYP (A)	P7	17	KH (A)	TB5	15					
2-1	605[6]/09	12AWG	ET064	EYJ (B)	J7	11	KR (B)	TB1	20	38C	7-3.101	D6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET064	EYP (A)	P7	11	KB (A)	TB1	7					
2-1	605[6]/09	12AWG	ET066	EYJ (B)	J7	9	KT (B)	TB3	5					
2-1	605[6]/09	12AWG	ET066	EYP (A)	P7	9	KT (A)	TB3	5					
2-1	605[6]/09	12AWG	ET070	EYJ (B)	J7	7	KB (B)	TB1	4					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	12AWG	ET070	EYP (A)	P7	7	KB (A)	TB1	4	38C	7-3.101	D6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG/TH32	ET081	EYJ (B)	J7	5	KH (B)	TB3	6	31A	7-3.89	H4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG/TH32	ET081	EYP (A)	P7	5	KH (A)	TB3	6					
2-1	605[6]/09	12AWG/TH31	ET082	EYJ (B)	J7	15	KH (B)	TB3	9					
2-1	605[6]/09	12AWG/TH31	ET082	EYP (A)	P7	15	KH (A)	TB3	9					
2-1	605[6]/09	12AWG/TH31	ET083	EYJ (B)	J7	16	KH (B)	TB3	10					
2-1	605[6]/09	12AWG/TH31	ET083	EYP (A)	P7	16	KH (A)	TB3	10					
2-1	605[6]/09	12AWG/TH33	ET084	EYJ (B)	J7	1	KH (B)	TB3	3					
2-1	605[6]/09	12AWG/TH33	ET084	EYP (A)	P7	1	KH (A)	TB3	3					
2-1	605[6]/09	12AWG/TH33	ET085	EYJ (B)	J7	2	KH (B)	TB3	4					
2-1	605[6]/09	12AWG/TH33	ET085	EYP (A)	P7	2	KH (A)	TB3	4					
2-1	605[6]/09	12AWG/TH32	ET086	EYJ (B)	J7	14	KH (B)	TB3	7					
2-1	605[6]/09	12AWG/TH32	ET086	EYP (A)	P7	14	KH (A)	TB3	7					
2-1	605[6]/09	12AWG	ET101	EYJ (B)	J7	13	KH (B)	TB4	4	22D	7-3.51	D5	ELECTRICAL T/L CONNECTION	SEE SH. 22B (PAGE 7-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	12AWG	ET101	EYP (A)	P7	13	KH (A)	TB4	4					
2-1	605[6]/09	2X16AWG	TH-14	EYP (A)	P10	42	KR (A)	TB7	11	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-150	EYJ (B)	J10	58	KB (B)	TB5	13					
2-1	605[6]/09	2X12AWG	TH-150	EYP (A)	P10	58	KB (A)	TB5	13					
2-1	605[6]/09	2X16AWG	TH-23	EYP (A)	P10	3	CW (A)	TB3	13	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X16AWG	TH-30	EYP (A)	P10	24	CB (A)	J4	15	31A	7-3.89	D4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-31	EYJ (B)	J7	3	KH (B)	TB3	11	31A	7-3.89	H4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-31	EYP (A)	P7	3	KH (A)	TB3	11					
2-1	605[6]/09	2X12AWG	TH-32	EYJ (B)	J7	3	KH (B)	TB3	8					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	605[6]/09	2X12AWG	TH-32	EYP (A)	P7	3	KH (A)	TB3	8	31A	7-3.89	H4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-33	EYJ (B)	J7	3	KH (B)	TB3	5					
2-1	605[6]/09	2X12AWG	TH-33	EYP (A)	P7	3	KH (A)	TB3	5					
2-1	605[6]/09	2X16AWG	TH-34	EYJ (B)	J10	3	CM (B)	/	/	31A	7-3.89	E4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X16AWG	TH-36	EYJ (B)	J10	24	CM (B)	P1	15	31A	7-3.89	D4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X16AWG	TH-38	EYJ (B)	J10	42	CW (B)	TB3	13	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-65	EYJ (B)	J7	19	KH (B)	TB5	13	29A	7-3.81	C5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-65	EYP (A)	P7	19	KH (A)	TB5	13	29A	7-3.81	D5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	605[6]/09	2X12AWG	TH-74	EYJ (B)	J7	35	AC (B)	A2-P1	25					
2-1	605[6]/09	2X12AWG	TH-74	EYP (A)	P7	35	AC (A)	A2-P1	25					
2-1	708/06	2/0AWG	R20	MQ (B)	/	HG	MP (B)	/	/	14	4-3.25	D(3-6)	BRAKE RESISTOR	
2-1	708/06	2/0AWG	R21	MQ (B)	/	DC-	MP (B)	/	/					
2-1	708/06	2/0AWG	T20	MQ (B)	/	RDB	MP (B)	/	/					
2-1	711/06	2/0AWG	R22	MQ (B)	/	DC-	MP (B)	/	/					
2-1	711/06	2/0AWG	R23	MQ (B)	/	HG	MP (B)	/	/					
2-1	711/06	2/0AWG	T21	MQ (B)	/	RDB	MP (B)	/	/					
2-1	HVR/A	6AWG	R11	HC (A)	V1	B	MH (A)	/	2	13	9-3.17	B6	HVAC PACKAGE	
2-1	HVR/A	6AWG	T11	HC (A)	V1	A	KD (A)	TB1	2					
2-1	HVR/B	6AWG	R15	HC (B)	V1	B	MH (B)	/	3					
2-1	HVR/B	6AWG	T15	HC (B)	V1	A	EYJ (B)	J6	B					
2-1	LVR/A	16AWG	14AF-1	EYP (A)	P11	b	KR (A)	TB2	3	22C	7-3.49	B5	ELECTRICAL T/L CONNECTION	SEE SH. 22A (PAGE 7-3.45FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 8 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	14EA-2	EYP (A)	P11	x	KR (A)	TB3	18	22C	7-3.49	A5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	17EA-11	EYP (A)	P11	y	KQ (A)	TB9	23	21F	7-3.43	C5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	17GA-2	AA (A)	P9	J	KR (A)	TB4	4	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	17HA-2	AA (A)	P9	K	KR (A)	TB4	3					
2-1	LVR/A	16AWG	17KA-3	EYP (A)	P11	AF	KR (A)	TB5	1	21F	7-3.43	A5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	17LA-2	EYP (A)	P11	AB	KR (A)	TB4	12	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	17MA-2	EYP (A)	P11	AC	KR (A)	TB4	13					
2-1	LVR/A	16AWG	18AA-12	AA (A)	P2	E	KB (A)	TB4	17	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	18AA-14	AA (A)	P2	b	KR (A)	TB1	7					
2-1	LVR/A	16AWG	18BA-12	AA (A)	P2	p	KB (A)	TB4	16					
2-1	LVR/A	16AWG	18BA-15	AA (A)	P2	c	KR (A)	TB1	8					
2-1	LVR/A	16AWG	18DA-13	AA (A)	P2	d	KR (A)	TB1	4					
2-1	LVR/A	16AWG	18DA-14	AA (A)	P2	h	KB (A)	TB3	16					
2-1	LVR/A	16AWG	18EA-12	AA (A)	P2	j	KB (A)	TB3	17					
2-1	LVR/A	16AWG	18EA-15	AA (A)	P2	e	KR (A)	TB1	5					
2-1	LVR/A	16AWG	18FB-20	EYP (A)	P11	s	KR (A)	TB5	11	21E	7-3.41	C5	ELECTRICAL T/L CONNECTION	SEE SH. 21A (PAGE 7-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	18GA-1	EYP (A)	P11	t	KR (A)	TB5	9					
2-1	LVR/A	16AWG	18HA-1	EYP (A)	P11	q	KR (A)	TB5	6					
2-1	LVR/A	16AWG	18ZA-26	EYP (A)	P11	r	KR (A)	TB5	10					
2-1	LVR/A	16AWG	26AA-7	AA (A)	P2	T	KQ (A)	TB3	5	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	26BA-2	AA (A)	P3	L	KQ (A)	TB1	14					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT/ SUB ASSEMBLY	
2-1	LVR/A	16AWG	26BA-4	EYP (A)	P11	AL	KQ (A)	TB1	14	15	7-3.47	C5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	26GA-2	EYP (A)	P11	AA	KQ (A)	TB1	10					
2-1	LVR/A	16AWG	26LA-2	EYP (A)	P11	BJ	KQ (A)	TB7	17					
2-1	LVR/A	16AWG	26LB-2	EYP (A)	P11	z	KQ (A)	TB7	18	15	7-3.47	B5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	28BA-1	EYP (A)	P11	X	KT (A)	TB1	2	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	28BB-4	MB (A)	/	D	EYP (A)	P11	a	41A	15-3.19	B5	PANTOGRAPH	SEE SH. 41 (PAGE 15-3.17 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	28CA-1	EYP (A)	P11	Y	KT (A)	TB1	3	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	28CB-4	MB (A)	/	L	EYP (A)	P11	Z	41A	15-3.19	B5	PANTOGRAPH	SEE SH. 41 (PAGE 15-3.17 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	28DA-1	MB (A)	/	B	KB (A)	TB5	7					
2-1	LVR/A	16AWG	28EA-1	MB (A)	/	C	KB (A)	TB5	8					
2-1	LVR/A	16AWG	28FA-1	MB (A)	/	J	KB (A)	TB5	9					
2-1	LVR/A	16AWG	31AF-2	HC (A)	V3	A	KQ (A)	TB4	20	48A	9-3.25	C5	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	34XA-1	KE (A)	1	1	EYP (A)	P11	AU	42C	11-3.39	B(5-6)	MAINTENANCE TELEPHONE JACK	SEE SH. 42B (PAGE 11-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	34XA-2	KE (A)	2	1	KE (A)	1	1					
2-1	LVR/A	16AWG	34YB-1	EYP (A)	P11	AK	KQ (A)	PSM	2	31A	7-3.89	H4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	34ZA-1	KE (A)	1	2	EYP (A)	P11	AT	42C	11-3.39	B(5-6)	MAINTENANCE TELEPHONE JACK	SEE SH. 42B (PAGE 11-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	34ZA-2	KE (A)	1	2	KE (A)	2	2					
2-1	LVR/A	16AW/TH142	35LA-2	PA (A)	P1	B3	CB (A)	J2	35	51E	17-3.63	G6	ATCS DIGITAL VOICE ANNUNCIATION	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449))
2-1	LVR/A	16AW/TH142	35MA-2	PA (A)	P1	A4	CB (A)	J2	36					
2-1	LVR/A	16AWG	35NA-2	PA (A)	P1	B2	CB (A)	J2	9					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	12AWG	36VA-1	EYP (A)	P8	15	KB (A)	TB5	14	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	36ZA-1	EYP (A)	P11	BM	KB (A)	TB5	6					
2-1	LVR/A	16AWG	41CC-5	EYP (A)	P11	AJ	KQ (A)	TB7	3	25A	7-3.139	C3	ELECTRICAL T/L CONNECTION	SEE SH. 25 (PAGE 7-3.89 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	41CD-5	EYP (A)	P11	AH	KQ (A)	TB7	2					
2-1	LVR/A	16AW/TH130	42FB-2	EYP (A)	P11	AW	KQ (A)	TB4	13	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AW/TH130	42KA-3	EYP (A)	P11	AV	KQ (A)	TB4	14					
2-1	LVR/A	16AW/TH136	42NA-3	AA (A)	P10	b	AC (A)	A1-P1	Z	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AW/TH136	42PA-3	AA (A)	P10	c	AC (A)	A1-P1	X					
2-1	LVR/A	16AW/TH133	42QA-3	AA (A)	P10	H	AC (A)	A1-P1	Y					
2-1	LVR/A	16AW/TH133	42RA-3	AA (A)	P10	J	AC (A)	A1-P1	U					
2-1	LVR/A	16AWG	43AD-4	EYP (A)	P11	AR	AC (A)	A1-P1	h	29A	7-3.81	A5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	44BC-2	EYP (A)	P11	P	KT (A)	TB1	12	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	44BC-39	EYP (A)	P11	BF	KT (A)	TB2	21	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	45EA-4	EYP (A)	P9	32	KQ (A)	TB3	7	26D	7-3.67	B6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46CA-3	EYP (A)	P11	BP	KQ (A)	TB6	21	26D	7-3.67	C6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46CB-3	EYP (A)	P11	BN	KQ (A)	TB6	8					
2-1	LVR/A	16AWG	46DA-3	EYP (A)	P11	BK	KQ (A)	TB8	18					
2-1	LVR/A	16AWG	46DB-3	EYP (A)	P11	BL	KQ (A)	TB8	22					
2-1	LVR/A	16AWG	46FA-3	EYP (A)	P11	f	KQ (A)	TB3	17	27D	7-3.75	C4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	46FB-4	EYP (A)	P11	j	KQ (A)	TB3	18	27D	7-3.75	B4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46FG-2	EYP (A)	P11	w	KR (A)	TB2	14					
2-1	LVR/A	16AWG	46KA-5	AA (A)	P2	F	KQ (A)	TB6	11	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46MA-10	EYP (A)	P11	v	KR (A)	TB2	20	43A	7-3.117	D5	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46MB-10	EYP (A)	P11	u	KR (A)	TB2	21					
2-1	LVR/A	16AWG	46RA-2	EYP (A)	P11	c	KR (A)	TB3	3	27D	7-3.75	D4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	46SA-2	EYP (A)	P11	d	KR (A)	TB3	10					
2-1	LVR/A	16AWG	47DA-5	EYP (A)	P11	H	KQ (A)	TB6	5	43A	7-3.117	D4	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	48BA-12	EYP (A)	P11	BR	KQ (A)	TB7	13	26D	7-3.67	C6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	48BD-2	EYP (A)	P11	BS	KQ (A)	TB7	16					
2-1	LVR/A	16AWG	48BE-2	EYP (A)	P11	BT	KQ (A)	TB7	23					
2-1	LVR/A	16AW/TH143	49AA-9	AW (A)	TB7	9	KX (A)	TB1	11	35	17-3.37	C5	ATCS TERMINAL BOARD PANEL	
2-1	LVR/A	16AW/TH143	49BA-9	AW (A)	TB7	10	KX (A)	TB1	12					
2-1	LVR/A	12AWG	50AD-2	EYP (A)	P9	31	KQ (A)	TB8	12	42A	7-3.109	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	12AWG	50AE-2	EYP (A)	P9	29	KQ (A)	TB4	5					
2-1	LVR/A	16AWG	54BA-2	EYP (A)	P11	BH	KT (A)	TB2	16	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	54CA-2	EYP (A)	P11	AY	KT (A)	TB2	15					
2-1	LVR/A	16AWG	54DA-2	EYP (A)	P11	AX	KT (A)	TB2	14					
2-1	LVR/A	16AWG	54EA-2	EYP (A)	P11	V	KT (A)	TB2	12	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	54FA-2	EYP (A)	P11	W	KT (A)	TB2	11					
2-1	LVR/A	16AWG	54GA-2	EYP (A)	P11	BD	KT (A)	TB2	10					
2-1	LVR/A	16AWG	55EA-3	EYP (A)	P11	BE	KT (A)	TB2	17	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 12 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	55KA-5	EYP (A)	P12	h	KB (A)	TB6	1	46A	7-3.125	E6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	55SC-2	EYP (A)	P11	AN	KB (A)	TB2	16	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	14AWG	56AA-3	EYP (A)	P11	AZ	KT (A)	TB2	4	47A	7-3.129	C5	ELECTRICAL T/L CONNECTION	SEE SH. 47 (PAGE 7-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	14AWG	56AC-3	EYP (A)	P11	BB	KQ (A)	TB5	4					
2-1	LVR/A	16AWG	56AD-13	EYP (A)	P12	d	KQ (A)	TB5	7					
2-1	LVR/A	16AWG	56DC-1	AW (A)	TB7	23	KT (A)	TB1	5					
2-1	LVR/A	16AWG	56FA-1	EYP (A)	P11	m	KQ (A)	TB10	11	47	7-3.127	C5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	14AWG	58AA-6	EYP (A)	P11	g	KQ (A)	TB3	19	27D	7-3.75	C4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	14AWG	58BA-6	EYP (A)	P11	h	KQ (A)	TB3	20					
2-1	LVR/A	12AWG/TH83	64AA-1	EYP (A)	P8	8	KH (A)	TB5	22	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG/TH90	64AA-6	AA (A)	P4	V	KQ (A)	TB8	8	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG/TH90	64AE-3	AA (A)	P4	U	KQ (A)	TB8	15					
2-1	LVR/A	16AWG	64BA-11	EYP (A)	P12	c	KB (A)	TB2	11	16	7-3.33	C5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	64CA-2	AA (A)	P2	X	KQ (A)	TB8	19	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	75BA-2	AA (A)	P10	W	KQ (A)	TB2	14					
2-1	LVR/A	16AWG	75GA-3	AA (A)	P3	f	KH (A)	TB7	9					
2-1	LVR/A	16AWG	75GB-2	AA (A)	P10	A	AC (A)	A2-P1	4					
2-1	LVR/A	16AWG	75JA-3	AA (A)	P10	B	AC (A)	A2-P1	2					
2-1	LVR/A	16AWG	80AA-2	EYP (A)	P11	L	KQ (A)	TB2	20	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	81EA-3	EYP (A)	P11	K	KT (A)	TB2	8	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	81EB-3	EYP (A)	P11	J	KT (A)	TB2	9					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	81SA-2	EYP (A)	P11	M	KT (A)	TB1	13	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	81TA-2	EYP (A)	P11	N	KT (A)	TB1	14					
2-1	LVR/A	16AWG	81UA-2	EYP (A)	P11	S	AC (A)	A1-P1	G					
2-1	LVR/A	16AWG	81VA-2	EYP (A)	P11	T	KT (A)	TB2	2					
2-1	LVR/A	16AWG	81WA-2	EYP (A)	P11	U	KT (A)	TB2	1					
2-1	LVR/A	16AWG	84YA-2	EYP (A)	P11	R	KT (A)	TB1	19					
2-1	LVR/A	16AWG	88JA-1	AW (A)	TB1	1	KT (A)	TB1	17	38C	7-3.101	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	88KA-2	AA (A)	P3	r	KB (A)	TB12	12	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	88LA-2	AA (A)	P10	S	KB (A)	TB12	13					
2-1	LVR/A	16AWG	88MA-2	AA (A)	P10	N	KB (A)	TB12	11					
2-1	LVR/A	12AWG	89AC-1	EYP (A)	P9	16	AN (A)	P1	W	51F	7-3.145	D5	ELECTRICAL T/L CONNECTION	SEE SH. 51C (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	89BA-1	EYP (A)	P9	18	ME (A)	P2	W	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.135 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	89JA-1	AA (A)	P2	L	AB (A)	P1	K	51F	17-3.65	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG/TH87	90FA-2	AW (A)	TB3	6	AE (A)	P1	F	51E	17-3.63	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG/TH87	90GA-2	AW (A)	TB3	5	AE (A)	P1	E					
2-1	LVR/A	16AWG	90HA-2	AW (A)	TB3	4	AE (A)	P1	C					
2-1	LVR/A	16AWG	90JA-2	AW (A)	TB3	3	AE (A)	P1	B					
2-1	LVR/A	16AWG	90KA-2	AW (A)	TB3	2	AE (A)	P1	K					
2-1	LVR/A	16AWG	90LA-2	AW (A)	TB3	1	AE (A)	P1	J					
2-1	LVR/A	16AWG	91AA-2	AW (A)	TB9	1	AN (A)	P1	P	51E	17-3.63	D7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	91BA-2	AW (A)	TB9	2	AN (A)	P1	R					
2-1	LVR/A	16AWG	91CA-2	AW (A)	TB9	3	AN (A)	P1	S					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	91DA-2	AW (A)	TB9	4	AN (A)	P1	T	51E	17-3.63	D7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	91EA-2	AW (A)	TB9	5	AN (A)	P1	U					
2-1	LVR/A	16AWG	91FA-2	AW (A)	TB9	6	AN (A)	P1	p					
2-1	LVR/A	16AWG	91GA-2	AW (A)	TB9	7	AN (A)	P1	n					
2-1	LVR/A	16AWG	91HA-2	AW (A)	TB9	8	AN (A)	P1	V					
2-1	LVR/A	16AWG	91JA-2	AW (A)	TB9	9	AN (A)	P1	N					
2-1	LVR/A	16AWG	91KA-2	AW (A)	TB9	10	AN (A)	P1	L					
2-1	LVR/A	16AWG	91LA-2	AW (A)	TB9	11	AN (A)	P1	g					
2-1	LVR/A	16AWG	91MA-2	AW (A)	TB9	12	AN (A)	P1	h					
2-1	LVR/A	16AWG	91TB-2	AA (A)	P9	j	AN (A)	P1	G	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	93AA-1	AW (A)	TB10	12	AC (A)	A2-P1	51	51E	17-3.63	B7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	93BA-1	AW (A)	TB10	11	AC (A)	A2-P1	50					
2-1	LVR/A	16AWG	93CA-1	AW (A)	TB10	10	AC (A)	A2-P1	49					
2-1	LVR/A	16AWG	93DA-1	AW (A)	TB10	9	AC (A)	A2-P1	48					
2-1	LVR/A	16AWG	93EA-1	AW (A)	TB10	8	AC (A)	A2-P1	33					
2-1	LVR/A	16AWG	93FA-1	AW (A)	TB10	7	AC (A)	A2-P1	32					
2-1	LVR/A	16AWG	93GA-1	AW (A)	TB10	6	AC (A)	A2-P1	31					
2-1	LVR/A	16AWG	93HA-1	AW (A)	TB10	5	AC (A)	A2-P1	30					
2-1	LVR/A	16AWG	93JA-1	AW (A)	TB10	4	AC (A)	A2-P1	29					
2-1	LVR/A	16AWG	93KA-1	AW (A)	TB10	3	AC (A)	A2-P1	28					
2-1	LVR/A	16AWG	93LA-1	AW (A)	TB10	2	AC (A)	A2-P1	27					
2-1	LVR/A	16AWG	93MA-1	AW (A)	TB10	1	AC (A)	A2-P1	26					
2-1	LVR/A	16AWG	94LA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	94MA-2	AW (A)	/	/	KB (A)	/	/					
2-1	LVR/A	16AWG	94NA-2	AW (A)	/	/	KB (A)	/	/					
2-1	LVR/A	16AWG	94PA-2	AW (A)	/	/	KB (A)	/	/					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	94QA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	94RA-2	AW (A)	/	/	KB (A)	/	/					
2-1	LVR/A	16AWG	94SA-2	AW (A)	/	/	KB (A)	/	/					
2-1	LVR/A	16AWG	95GA-2	AA (A)	P2	m	AB (A)	P1	B	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	95HA-2	AA (A)	P3	B	AB (A)	P1	A					
2-1	LVR/A	18AWG/TH97	95JA-30	AA (A)	CU1	2	PA (A)	J2	3					
2-1	LVR/A	18AWG/TH97	95KA-30	AA (A)	CU1	3	PA (A)	J2	2					
2-1	LVR/A	18AWG/TH97	95TA-30	AA (A)	CU1	4	PA (A)	J2	7					
2-1	LVR/A	18AWG/TH97	95UA-30	AA (A)	CU1	7	PA (A)	J2	5					
2-1	LVR/A	16AWG	95VA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	C11-3	EYP (A)	P11	BU	KQ (A)	TB3	21	26C	7-3.65	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26A (PAGE 7-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET011-8	EYP (A)	P8	17	KB (A)	TB1	20	22D	7-3.49	C5	ELECTRICAL T/L CONNECTION	SEE SH. 22B (PAGE 7-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET011-9	EYP (A)	P8	18	KB (A)	TB1	21					
2-1	LVR/A	12AWG	ET013-4	EYP (A)	P9	14	KR (A)	TB1	21	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET014-4	EYP (A)	P9	13	KR (A)	TB1	20					
2-1	LVR/A	12AWG	ET019	EYP (A)	P8	35	KB (A)	TB6	2	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET019-3	AA (A)	P3	a	KB (A)	TB6	2	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET019-6	EYP (A)	P11	BC	KB (A)	TB2	17	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET021	EYP (A)	P9	35	KT (A)	TB3	7	48A	7-3.133	D5	ELECTRICAL T/L CONNECTION	SEE SH. 48 (PAGE 7-3.131FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	12AWG	ET022	EYP (A)	P9	24	KH (A)	TB2	19	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET023	EYP (A)	P9	25	KH (A)	TB2	20	41A	7-3.107	B5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET024	EYP (A)	P9	12	KQ (A)	TB2	19	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET025	EYP (A)	P9	11	KQ (A)	TB2	18					
2-1	LVR/A	12AWG	ET027	EYP (A)	P9	9	KH (A)	TB2	21	26D	7-3.67	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET027-6	AA (A)	P10	g	KQ (A)	TB6	22	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET033-7	AW (A)	TB1	13	KQ (A)	TB5	2	47A	7-3.129	C8	ATCS TERMINAL BOARD PANEL	SEE SH. 47 (PAGE 7-3.127FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET035	EYP (A)	P8	33	KB (A)	TB6	3	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET035-3	AA (A)	P3	b	KB (A)	TB6	3	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET036	AW (A)	TB3	12	KB (A)	TB6	11	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET037	EYP (A)	P8	32	KB (A)	TB6	4	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET037-3	AA (A)	P3	c	KB (A)	TB6	4	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET038	AW (A)	TB3	11	KH (A)	TB3	13	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	12AWG	ET039	EYP (A)	P8	34	KB (A)	TB6	8	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET041-6	AA (A)	P10	X	KB (A)	TB1	8	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET043	EYP (A)	P9	26	KQ (A)	TB7	1	25A	7-3.59	D3	ELECTRICAL T/L CONNECTION	SEE SH. 25 (PAGE 7-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET046	EYP (A)	P8	20	KH (A)	TB3	17	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET046-7	AA (A)	P3	k	KQ (A)	TB7	12	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET047	EYP (A)	P9	10	KH (A)	TB3	18	26D	7-3.67	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET047-3	AA (A)	P10	h	KQ (A)	TB10	3	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	10AWG	ET048	EYP (A)	P8	25	KH (A)	TB1	1	15	7-3.79	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	10AWG	ET049	EYP (A)	P8	27	KH (A)	TB1	3					
2-1	LVR/A	12AWG	ET049-25	AA (A)	P10	m	KQ (A)	TLN1	/	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG/TH72	ET050-2	AW (A)	TB4	20	KQ (A)	TB9	13	29A	17-3.31	B6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG/TH83	ET052	EYP (A)	P8	7	KH (A)	TB5	12	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET053-4	AA (A)	P3	M	KQ (A)	TB9	22	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET054-4	AA (A)	P3	T	KQ (A)	TB9	21					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	12AWG/TH80	ET055	EYP (A)	P8	4	KH (A)	TB5	20	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET055-4	AA (A)	P2	G	KH (A)	TB5	20	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG/TH80	ET056	EYP (A)	P8	5	KH (A)	TB5	21	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET056-4	AA (A)	P2	H	KH (A)	TB5	21	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET057	EYP (A)	P8	1	KH (A)	TB4	6	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET057-2	AA (A)	P2	g	KQ (A)	TB8	17	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET058	EYP (A)	P8	2	KH (A)	TB4	7	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET058-1	AA (A)	P2	f	KH (A)	TB4	7	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET059-1	AA (A)	P3	G	KQ (A)	TB7	10					
2-1	LVR/A	12AWG	ET060	EYP (A)	P8	22	KB (A)	TB5	1	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET060-2	AA (A)	P3	J	KB (A)	TB5	1	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET061	EYP (A)	P8	31	KH (A)	TB4	10	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET061-8	AA (A)	P3	A	KB (A)	TB12	9	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET062	EYP (A)	P8	30	KH (A)	TB4	11	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	ET062-8	AA (A)	P10	M	KB (A)	TB12	10	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET063	EYP (A)	P8	19	KB (A)	TB5	4	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	ET064-6	AA (A)	P3	e	KB (A)	TB1	7	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET065	EYP (A)	P8	16	KB (A)	TB6	7	(*) 37A	/	/	/	(*) SHEET DELETED
2-1	LVR/A	16AWG	ET066-7	AA (A)	P3	g	KQ (A)	TB2	23	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET067	EYP (A)	P8	3	KH (A)	TB4	16	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	16AWG	ET067-3	AA (A)	P2	J	KB (A)	TB2	1	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET068	EYP (A)	P8	24	KH (A)	TB1	5	15	7-3.79	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	12AWG	ET069	EYP (A)	P8	26	KH (A)	TB1	7					
2-1	LVR/A	12AWG	ET069-28	AA (A)	P10	n	KQ (A)	TLP1	/	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET071	EYP (A)	P8	28	KH (A)	TB4	18	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	12AWG	ET071-11	EYP (A)	P9	33	KQ (A)	TB3	6	26D	7-3.67	B6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET072	EYP (A)	P8	29	KH (A)	TB4	19	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	12AWG	ET073	EYP (A)	P8	23	KB (A)	TB5	5	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	16AWG	ET073-3	AA (A)	P3	K	KB (A)	TB5	5	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET075	EYP (A)	P9	30	KB (A)	TB6	6	(*) 37A	/	/	/	(*) SHEET DELETED
2-1	LVR/A	12AWG/TH72	ET087-1	AW (A)	TB4	19	KQ (A)	TB9	14	29A	17-3.31	B6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET089	AW (A)	TB3	10	KH (A)	TB6	1	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET090	AA (A)	P4	E	KH (A)	TB6	2	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET091	AA (A)	P2	A	KH (A)	TB6	3					
2-1	LVR/A	12AWG	ET092	AA (A)	P2	C	KH (A)	TB6	4					
2-1	LVR/A	12AWG	ET094	AA (A)	P2	N	KH (A)	TB6	6	51F	17-3.65	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51C (PAGE 17-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AW/TH126	ET095	AW (A)	TB3	14	KH (A)	TB6	7	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-1	LVR/A	12AW/TH126	ET096	AW (A)	TB3	13	KH (A)	TB6	8					
2-1	LVR/A	12AWG	ET097	AA (A)	P2	R	KH (A)	TB6	10	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET098	AW (A)	TB3	20	KT (A)	TB1	21	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 7-3.135 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	ET099	AW (A)	TB3	18	KH (A)	TB4	2					
2-1	LVR/A	12AWG	ET100	AW (A)	TB3	19	KH (A)	TB4	3					
2-1	LVR/A	16AWG	ET101-3	AA (A)	P3	m	KR (A)	TB4	11	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	G21-1	AW (A)	TB3	15	MX (A)	A11	/	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-1	LVR/A	14AWG	NB18	HC (A)	V3	B	KB (A)	NB AUX.	11	48A	9-3.25	C5	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	12AWG	NB24	AA (A)	P10	r	KB (A)	NB AUX.	15	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	NB32	MB (A)	/	E	KB (A)	NB AUX.	19	41A	15-3.19	B5	PANTOGRAPH	SEE SH. 41 (PAGE 15-3.17 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	10AWG	NB33	MB (A)	/	F	KB (A)	NB AUX.	20					
2-1	LVR/A	16AWG	NB42-2	AA (A)	P3	W	KQ (A)	TB1	20	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	14AWG	NB8-4	EYP (A)	P11	i	KB (A)	TB3	7	27D	7-3.75	B4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	SPARE36	EYP (A)	P12	g	KB (A)	/	/	/				
2-1	LVR/A	16AWG	SPARE38	EYP (A)	P12	i	KB (A)	/	/	/				
2-1	LVR/A	16AWG	SPARE39	EYP (A)	P12	j	KB (A)	/	/	/				
2-1	LVR/A	16AWG	SPARE40	EYP (A)	P12	k	KB (A)	/	/	/				
2-1	LVR/A	2X12AWG	TH-126	AW (A)	TB3	15	KH (A)	/	/	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-1	LVR/A	2X16AWG	TH-130	EYP (A)	P11	AM	KQ (A)	TB4	8	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X16AWG	TH-133	AA (A)	P10	e	AC (A)	A1-P1	V	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X16AWG	TH-136	AA (A)	P10	d	AC (A)	A1-P1	W					
2-1	LVR/A	2X16AWG	TH-142	PA (A)	P1	B4	CB (A)	/	/	51E	17-3.63	G6	ATCS DIGITAL VOICE ANNUNCIATION	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X16AWG	TH-143	AW (A)	TB7	11	KX (A)	TB1	13	35	17-3.37	C5	ATCS TERMINAL BOARD PANEL	
2-1	LVR/A	2X12AWG	TH-72	AW (A)	TB4	21	KQ (A)	TB9	20	29A	17-3.31	B6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X12AWG	TH-80	EYP (A)	P8	6	KH (A)	TB5	19	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/A	2X12AWG	TH-83	EYP (A)	P8	6	KH (A)	TB5	10					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/A	2X16AWG	TH-87	AW (A)	TB3	7	AE (A)	P1	L	51E	17-3.63	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X16AWG	TH-90	AA (A)	/	/	KQ (A)	TB8	6	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	2X18AWG	TH-97	AA (A)	CU1	1	PA (A)	/	/					
2-1	LVR/A	16AWG	X16-8	EYP (A)	P11	F	KQ (A)	TB6	10	43A	7-3.117	D4	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	14AWG	X18-4	HC (A)	V3	J	KQ (A)	TB4	19	48A	9-3.25	C5	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	X19-4	EYP (A)	P12	f	KT (A)	TB2	19	47A	7-3.33	B5	ELECTRICAL T/L CONNECTION	SEE SH. 47 (PAGE 7-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	12AWG	X24-2	AA (A)	P10	p	KB (A)	TB12	1	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	X29-36	EYP (A)	P11	AP	KB (A)	TB2	15	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	16AWG	X32-4	MB (A)	/	A	KQ (A)	TB3	12	41A	15-3.19	B5	PANTOGRAPH	SEE SH. 41 (PAGE 15-3.17 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/A	10AWG	X33-2	MB (A)	/	K	KB (A)	TB9	12					
2-1	LVR/B	16AWG	14AF-1	EYJ (B)	J11	b	KR (B)	TB2	20	22C	7-3.49	B5	ELECTRICAL T/L CONNECTION	SEE SH. 22A (PAGE 7-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	14EA-2	EYJ (B)	J11	x	KR (B)	TB2	21	22C	7-3.49	A5	ELECTRICAL T/L CONNECTION	SEE SH. 22A (PAGE 7-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	17EA-11	EYJ (B)	J11	y	KQ (B)	TB4	15	21F	7-3.43	C5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	17KA-3	EYJ (B)	J11	AF	KT (B)	TB1	2	21F	7-3.43	A5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	18AA-12	EYJ (B)	J12	R	KB (B)	TB12	6	21E	7-3.41	B5	ELECTRICAL T/L CONNECTION	SEE SH. 21A (PAGE 7-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	18BA-12	EYJ (B)	J12	P	KB (B)	TB12	5					
2-1	LVR/B	16AWG	18DA-14	EYJ (B)	J12	M	KB (B)	TB12	1	21E	7-3.41	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21A (PAGE 7-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	18EA-12	EYJ (B)	J12	N	KB (B)	TB12	2					
2-1	LVR/B	16AWG	18FB-3	EYJ (B)	J11	s	AC (B)	A2-P2	G	21E	7-3.41	C5	ELECTRICAL T/L CONNECTION	SEE SH. 21A (PAGE 7-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	18GA-1	EYJ (B)	J11	t	KR (B)	TB5	9					
2-1	LVR/B	16AWG	18HA-1	EYJ (B)	J11	q	KR (B)	TB5	6					
2-1	LVR/B	16AWG	18ZA-25	EYJ (B)	J11	r	KR (B)	TB3	21					
2-1	LVR/B	16AWG	26AA-7	EYJ (B)	J12	S	KQ (B)	TB1	22	15	7-3.31	A5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	16AWG	26BA-4	EYJ (B)	J11	AL	KQ (B)	TB1	14	15	7-3.31	C5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	16AWG	26GA-2	EYJ (B)	J11	AA	KQ (B)	TB1	6					
2-1	LVR/B	16AWG	26LA-2	EYJ (B)	J11	BJ	KQ (B)	TB1	23					
2-1	LVR/B	16AWG	26LB-2	EYJ (B)	J11	z	KQ (B)	TB1	16	15	7-3.31	B5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	16AWG	28BA-1	EYJ (B)	J11	X	KT (B)	TB1	7	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	28BB-3	EYJ (B)	J11	a	KT (B)	TB1	10	41A	7-3.107	C5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	28CA-1	EYJ (B)	J11	Y	KT (B)	TB1	8	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	28CB-3	EYJ (B)	J11	Z	KT (B)	TB1	9	41A	7-3.107	C5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	31AF-2	HC (B)	V3	A	KQ (B)	TB5	9	48A	9-3.25	C4	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	34XA-1	KE (B)	1	1	EYJ (B)	J11	AU	42C	11-3.39	B(3-4)	MAINTENANCE TELEPHONE JACK	SEE SH. 42B (PAGE 11-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	34XA-2	KE (B)	1	1	KE (B)	2	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	34YB-2	EYJ (B)	J11	AK	KQ (B)	TB5	16	31A	7-3.89	F4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	34ZA-1	EYJ (B)	J11	AT	KE (B)	1	2	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	34ZA-2	KE (B)	1	2	KE (B)	2	2	42C	11-3.39	B(3-4)	MAINTENANCE TELEPHONE JACK	SEE SH. 42B (PAGE 11-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	36VA-1	EYJ (B)	J8	15	KB (B)	TB5	14	31A	7-3.89	B4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	36ZA-1	EYJ (B)	J11	BM	KB (B)	TB5	6					
2-1	LVR/B	16AWG	41CC-6	EYJ (B)	J11	AJ	KT (B)	TB1	6	25A	7-3.75	C3	ELECTRICAL T/L CONNECTION	SEE SH. 25 (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	41CD-6	EYJ (B)	J11	AH	KT (B)	TB1	5					
2-1	LVR/B	16AW/TH130	42FB-2	EYJ (B)	J11	AW	KQ (B)	TB4	13	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AW/TH130	42KA-3	EYJ (B)	J11	AV	KQ (B)	TB4	14					
2-1	LVR/B	16AW/TH136	42NA-3	EYJ (B)	J12	A	AC (B)	A1-P1	Z	42C	7-3.113	D4	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AW/TH136	42PA-3	EYJ (B)	J12	B	AC (B)	A1-P1	X	42C	7-3.113	C4	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AW/TH133	42QA-3	EYJ (B)	J12	D	AC (B)	A1-P1	Y					
2-1	LVR/B	16AW/TH133	42RA-3	EYJ (B)	J12	E	AC (B)	A1-P1	U					
2-1	LVR/B	16AWG	43AD-4	EYJ (B)	J11	AR	KQ (B)	TB9	20	29A	7-3.107	A5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	44BC-1	EYJ (B)	J11	P	KR (B)	TB1	18	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	44BC-39	EYJ (B)	J11	BF	FV (B)	TB4	5	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	45EA-4	EYJ (B)	J9	32	KQ (B)	TB3	20	26D	7-3.67	B6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	46CA-3	EYJ (B)	J11	BP	AC (B)	A2-P2	f	26D	7-3.67	C6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	46CB-3	EYJ (B)	J11	BN	KQ (B)	TB8	7					
2-1	LVR/B	16AWG	46DA-3	EYJ (B)	J11	BK	KT (B)	TB1	3					
2-1	LVR/B	16AWG	46DB-3	EYJ (B)	J11	BL	KT (B)	TB1	4					
2-1	LVR/B	16AWG	46FA-3	EYJ (B)	J11	f	KR (B)	TB2	17	27D	7-3.75	C4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	46FB-4	EYJ (B)	J11	j	KQ (B)	TB3	18	27D	7-3.75	B4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	46FG-2	EYJ (B)	J11	w	KR (B)	TB2	16					
2-1	LVR/B	16AWG	46MA-2	EYJ (B)	J11	v	KQ (B)	TB6	6	43A	7-3.117	D5	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	46MB-2	EYJ (B)	J11	u	KQ (B)	TB6	9					
2-1	LVR/B	16AWG	46RA-1	EYJ (B)	J11	c	VE (B)	J2	16	27D	7-3.75	D4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	46SA-1	EYJ (B)	J11	d	VE (B)	J2	14					
2-1	LVR/B	16AWG	47DA-5	EYJ (B)	J11	H	KQ (B)	TB6	5	43A	7-3.117	D4	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	48BA-11	EYJ (B)	J11	BR	KQ (B)	TB7	1	26D	7-3.67	C6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	50AD-2	EYJ (B)	J9	31	KQ (B)	TB4	5	42A	7-3.109	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	50AE-2	EYJ (B)	J9	29	KQ (B)	TB8	12					
2-1	LVR/B	16AWG	51AA-10	EYJ (B)	J11	BV	KQ (B)	TB3	13	26C	7-3.65	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26A (PAGE 7-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	54BA-1	EYJ (B)	J11	BH	KF (B)	TB1	1	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	54CA-1	EYJ (B)	J11	AY	KF (B)	TB1	2					
2-1	LVR/B	16AWG	54DA-1	EYJ (B)	J11	AX	KF (B)	TB1	3					
2-1	LVR/B	16AWG	54EA-2	EYJ (B)	J11	V	KT (B)	TB2	12	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	54FA-2	EYJ (B)	J11	W	KT (B)	TB2	11					
2-1	LVR/B	16AWG	54GA-2	EYJ (B)	J11	BD	KT (B)	TB2	10					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	55EA-3	EYJ (B)	J11	BE	KT (B)	TB2	17	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	55KA-6	EYJ (B)	J12	h	FV (B)	TB2	21	46A	7-3.125	E6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	55SC-1	EYJ (B)	J11	AN	FV (B)	TB1	15	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	56AA-3	EYJ (B)	J11	AZ	KT (B)	TB2	4	47A	7-3.67	C5	ELECTRICAL T/L CONNECTION	SEE SH. 47 (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	56AC-3	EYJ (B)	J11	BB	KT (B)	TB2	5					
2-1	LVR/B	16AWG	56AD-13	EYJ (B)	J12	d	KQ (B)	TB6	22					
2-1	LVR/B	16AWG	56DC-4	EYJ (B)	J12	a	KT (B)	TB2	8					
2-1	LVR/B	14AWG	58AA-6	EYJ (B)	J11	g	KB (B)	TB2	1	27D	7-3.75	C4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	58BA-6	EYJ (B)	J11	h	KB (B)	TB2	8					
2-1	LVR/B	12AWG/TH83	64AA-1	EYJ (B)	J8	8	KH (B)	TB5	22	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	16AWG	64BA-3	EYJ (B)	J12	c	KQ (B)	TB8	17	16	7-3.33	C5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	16AWG	75BA-2	EYJ (B)	J12	T	KQ (B)	TB2	14	24A	7-3.55	C5	ELECTRICAL T/L CONNECTION	SEE SH. 24 (PAGE 7-3.53 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	75GA-3	EYJ (B)	J12	J	KH (B)	TB7	9					
2-1	LVR/B	16AWG	75GB-2	EYJ (B)	J12	K	AC (B)	A2-P1	4					
2-1	LVR/B	16AWG	75JA-3	EYJ (B)	J12	L	AC (B)	A2-P1	2					
2-1	LVR/B	16AWG	80AA-2	EYJ (B)	J11	L	KT (B)	TB1	12	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	81EA-2	EYJ (B)	J11	K	KB (B)	TB2	4	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	81EB-4	EYJ (B)	J11	J	KT (B)	TB2	9					
2-1	LVR/B	16AWG	81SA-2	EYJ (B)	J11	M	KT (B)	TB1	13	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	81TA-2	EYJ (B)	J11	N	KT (B)	TB1	14					
2-1	LVR/B	16AWG	81UA-2	EYJ (B)	J11	S	KB (B)	TB1	6					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	81VA-2	EYJ (B)	J11	T	KT (B)	TB2	2	38C	7-3.101	C6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	81WA-2	EYJ (B)	J11	U	KT (B)	TB2	1					
2-1	LVR/B	16AWG	84YA-2	EYJ (B)	J11	R	KT (B)	TB1	19					
2-1	LVR/B	16AWG	88JA-3	EYJ (B)	J11	BA	KT (B)	TB1	17	38C	7-3.101	A6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	88MA-12	EYJ (B)	J12	Z	KB (B)	TB12	11	15	7-3.47	A5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	89AC-1	EYJ (B)	J9	16	AN (B)	P1	W	51F	7-3.145	D5	ELECTRICAL T/L CONNECTION	SEE SH. 51C (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	89BA-1	EYJ (B)	J9	18	ME (B)	P2	W	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	89DA-1	EYJ (B)	J12	H	AB (B)	P1	K	51F	7-3.145	D5	ELECTRICAL T/L CONNECTION	SEE SH. 51C (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	91AA-2	EYJ (B)	J12	BF	AN (B)	P1	P	51E	7-3.143	D3	ELECTRICAL T/L CONNECTION	SEE SH. 51B (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	91BA-2	EYJ (B)	J12	BE	AN (B)	P1	R					
2-1	LVR/B	16AWG	91CA-2	EYJ (B)	J12	BD	AN (B)	P1	S					
2-1	LVR/B	16AWG	91DA-2	EYJ (B)	J12	BC	AN (B)	P1	T					
2-1	LVR/B	16AWG	91EA-2	EYJ (B)	J12	BB	AN (B)	P1	U					
2-1	LVR/B	16AWG	91FA-2	EYJ (B)	J12	BA	AN (B)	P1	p					
2-1	LVR/B	16AWG	91GA-2	EYJ (B)	J12	AZ	AN (B)	P1	n					
2-1	LVR/B	16AWG	91HA-2	EYJ (B)	J12	AY	AN (B)	P1	V					
2-1	LVR/B	16AWG	91JA-2	EYJ (B)	J12	AX	AN (B)	P1	N					
2-1	LVR/B	16AWG	91KA-2	EYJ (B)	J12	AW	AN (B)	P1	L					
2-1	LVR/B	16AWG	91LA-2	EYJ (B)	J12	AV	AN (B)	P1	g					
2-1	LVR/B	16AWG	91MA-2	EYJ (B)	J12	AU	AN (B)	P1	h					
2-1	LVR/B	16AWG	91TA-2	EYJ (B)	J12	AT	AN (B)	P1	G					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	92HA-2	EYJ (B)	J12	AL	AN (B)	/	/	51E	7-3.143	E3	ELECTRICAL T/L CONNECTION	SEE SH. 51B (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	92JA-2	EYJ (B)	J12	AM	AN (B)	/	/					
2-1	LVR/B	16AWG	92KA-2	EYJ (B)	J12	AN	AN (B)	/	/					
2-1	LVR/B	16AWG	92LA-2	EYJ (B)	J12	AP	AN (B)	/	/					
2-1	LVR/B	16AWG	92MA-2	EYJ (B)	J12	AR	AN (B)	/	/					
2-1	LVR/B	16AWG	92NA-2	EYJ (B)	J12	AS	AN (B)	/	/					
2-1	LVR/B	16AWG	93AA-1	EYJ (B)	J12	BH	AC (B)	A2-P1	51	51E	7-3.143	C3	ELECTRICAL T/L CONNECTION	SEE SH. 51B (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	93BA-1	EYJ (B)	J12	BJ	AC (B)	A2-P1	50					
2-1	LVR/B	16AWG	93CA-1	EYJ (B)	J12	BK	AC (B)	A2-P1	49					
2-1	LVR/B	16AWG	93DA-1	EYJ (B)	J12	BL	AC (B)	A2-P1	48					
2-1	LVR/B	16AWG	93EA-1	EYJ (B)	J12	BM	AC (B)	A2-P1	33					
2-1	LVR/B	16AWG	93FA-1	EYJ (B)	J12	BN	AC (B)	A2-P1	32					
2-1	LVR/B	16AWG	93GA-1	EYJ (B)	J12	BP	AC (B)	A2-P1	31					
2-1	LVR/B	16AWG	93HA-1	EYJ (B)	J12	BR	AC (B)	A2-P1	30					
2-1	LVR/B	16AWG	93JA-1	EYJ (B)	J12	BS	AC (B)	A2-P1	29					
2-1	LVR/B	16AWG	93KA-1	EYJ (B)	J12	BT	AC (B)	A2-P1	28					
2-1	LVR/B	16AWG	93LA-1	EYJ (B)	J12	BU	AC (B)	A2-P1	27					
2-1	LVR/B	16AWG	93MA-1	EYJ (B)	J12	BV	AC (B)	A2-P1	26					
2-1	LVR/B	16AWG	94QA-2	EYJ (B)	J12	q	KB (B)	/	/	51E	7-3.143	G3	ELECTRICAL T/L CONNECTION	SEE SH. 51B (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	94RA-2	EYJ (B)	J12	p	KB (B)	/	/					
2-1	LVR/B	16AWG	94SA-2	EYJ (B)	J12	n	KB (B)	/	/					
2-1	LVR/B	16AWG	94TA-2	EYJ (B)	J12	m	KB (B)	/	/					
2-1	LVR/B	16AWG	95GA-2	EYJ (B)	J12	v	AB (B)	P1	B					
2-1	LVR/B	16AWG	95HA-2	EYJ (B)	J12	w	AB (B)	P1	A					
2-1	LVR/B	16AWG/TH98	95JA-2	EYJ (B)	J12	x	PA (B)	/	/					
2-1	LVR/B	16AWG/TH98	95KA-2	EYJ (B)	J12	y	PA (B)	/	/					
2-1	LVR/B	16AWG	95TA-2	EYJ (B)	J12	b	PA (B)	/	/					
2-1	LVR/B	16AWG	95UA-2	EYJ (B)	J12	AJ	PA (B)	/	/					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
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RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	C11-10	EYJ (B)	J11	BU	KQ (B)	TB3	14	26C	7-3.65	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26A (PAGE 7-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET011-20	EYJ (B)	J8	17	KB (B)	TB1	20	22D	7-3.51	C5	ELECTRICAL T/L CONNECTION	SEE SH. 22B (PAGE 7-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET011-26	EYJ (B)	J8	18	KB (B)	TB1	21					
2-1	LVR/B	12AWG	ET013	EYJ (B)	J9	14	KQ (B)	TB2	17	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET014	EYJ (B)	J9	13	KQ (B)	TB2	16					
2-1	LVR/B	12AWG	ET019	EYJ (B)	J8	35	KR (B)	TB1	5	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	ET019-5	EYJ (B)	J11	BC	KR (B)	TB1	1	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET020	EYJ (B)	J9	19	KH (B)	TB7	8	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET021	EYJ (B)	J9	35	KT (B)	TB3	7	48A	7-3.143	D5	ELECTRICAL T/L CONNECTION	SEE SH. 48 (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET022	EYJ (B)	J9	24	KB (B)	TB5	9	41A	7-3.107	D5	ELECTRICAL T/L CONNECTION	SEE SH. 41 (PAGE 7-3.105 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET023	EYJ (B)	J9	25	KB (B)	TB5	10					
2-1	LVR/B	12AWG	ET024	EYJ (B)	J9	11	KQ (B)	TB2	19	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET025	EYJ (B)	J9	12	KQ (B)	TB2	18					
2-1	LVR/B	12AWG	ET027	EYJ (B)	J9	9	KH (B)	TB2	21	26D	7-3.67	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET035	EYJ (B)	J8	33	KR (B)	TB1	2	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET036	EYJ (B)	J9	7	KB (B)	TB6	11	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 30 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	12AWG	ET037	EYJ (B)	J8	32	KR (B)	TB1	3	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET038	EYJ (B)	J9	6	KH (B)	TB3	13	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET039	EYJ (B)	J8	34	KB (B)	TB6	8	46A	7-3.125	D6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET043	EYJ (B)	J9	26	KB (B)	TB4	18	25A	7-3.59	D3	ELECTRICAL T/L CONNECTION	SEE SH. 25 (PAGE 7-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET046	EYJ (B)	J8	20	KH (B)	TB3	17	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET047	EYJ (B)	J9	10	KH (B)	TB3	18	26D	7-3.67	D5	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	10AWG	ET048	EYJ (B)	J8	25	KH (B)	TB1	1	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	10AWG	ET049	EYJ (B)	J8	27	KH (B)	TB1	3					
2-1	LVR/B	12AWG/TH72	ET050-2	EYJ (B)	J9	21	KQ (B)	TB9	9	29A	7-3.81	B5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG/TH83	ET052	EYJ (B)	J8	7	KH (B)	TB5	12	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG/TH80	ET055	EYJ (B)	J8	5	KH (B)	TB5	20					
2-1	LVR/B	12AWG/TH80	ET056	EYJ (B)	J8	4	KH (B)	TB5	21					
2-1	LVR/B	12AWG	ET057	EYJ (B)	J8	1	KH (B)	TB4	6					
2-1	LVR/B	12AWG	ET058	EYJ (B)	J8	2	KH (B)	TB4	7					
2-1	LVR/B	12AWG	ET059-1	EYJ (B)	J8	21	KQ (B)	TB7	10	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET060	EYJ (B)	J8	22	KQ (B)	TB7	7					
2-1	LVR/B	12AWG	ET061	EYJ (B)	J8	31	KH (B)	TB4	10	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	ET062	EYJ (B)	J8	30	KH (B)	TB4	11					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 31 of 33

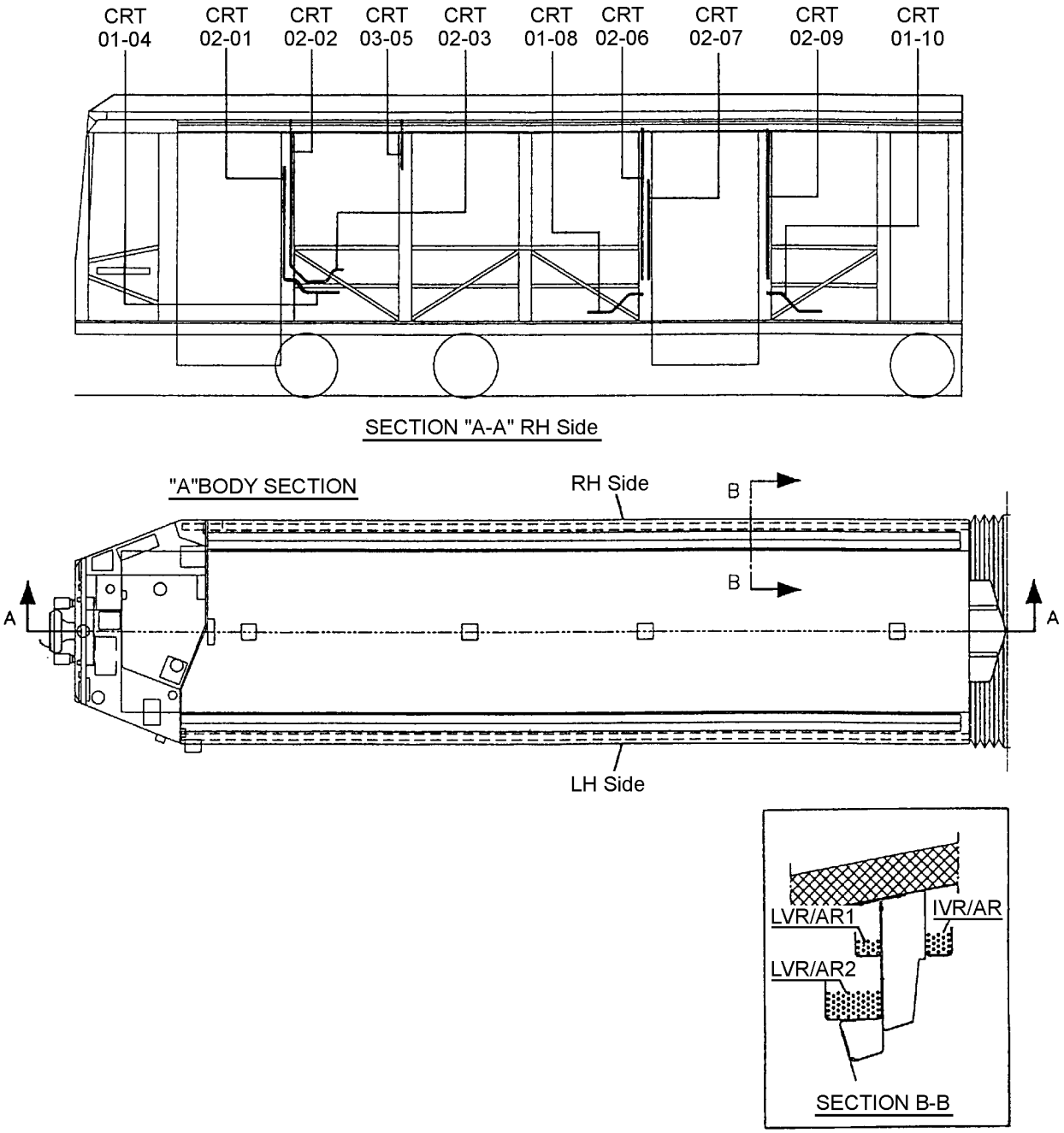
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	ET062-8	EYJ (B)	J12	W	KB (B)	TB12	12	15	7-3.31	A5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	ET063	EYJ (B)	J8	19	KB (B)	TB5	4	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET065	EYJ (B)	J8	16	KB (B)	TB6	7	(*) 37A	/	/	/	(*) SHEET DELETED
2-1	LVR/B	12AWG	ET067	EYJ (B)	J8	3	KH (B)	TB4	16	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	ET068	EYJ (B)	J8	24	KH (B)	TB1	5	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	ET069	EYJ (B)	J8	26	KH (B)	TB1	7					
2-1	LVR/B	12AWG	ET071	EYJ (B)	J8	28	KH (B)	TB4	18					
2-1	LVR/B	12AWG	ET071-11	EYJ (B)	J9	33	KQ (B)	TB3	19	26D	7-3.67	B6	ELECTRICAL T/L CONNECTION	SEE SH. 26B (PAGE 7-3.63 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET072	EYJ (B)	J8	29	KH (B)	TB4	19	15	7-3.31	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	12AWG	ET073	EYJ (B)	J8	23	KQ (B)	TB7	13	32A	7-3.93	D5	ELECTRICAL T/L CONNECTION	SEE SH. 32 (PAGE 7-3.91 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET075	EYJ (B)	J9	30	KB (B)	TB6	6	(*) 37A	/	/	/	(*) SHEET DELETED
2-1	LVR/B	12AWG/TH72	ET087-1	EYJ (B)	J9	22	KQ (B)	TB9	11	29A	7-3.81	B5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET089	EYJ (B)	J9	4	KH (B)	TB6	1	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET090	EYJ (B)	J9	5	KH (B)	TB6	2					
2-1	LVR/B	12AWG	ET091	EYJ (B)	J9	15	KH (B)	TB6	3					
2-1	LVR/B	12AWG	ET092	EYJ (B)	J9	34	KH (B)	TB6	4					
2-1	LVR/B	12AWG	ET093	EYJ (B)	J9	17	KH (B)	TB6	5	51F	7-3.145	D5	ELECTRICAL T/L CONNECTION	SEE SH. 51C (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AW/TH126	ET095	EYJ (B)	J9	1	KH (B)	TB6	7	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AW/TH126	ET096	EYJ (B)	J9	2	KH (B)	TB6	8					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 32 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	12AWG	ET098	EYJ (B)	J9	28	KT (B)	TB1	21	51D	7-3.141	C4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	12AWG	ET099	EYJ (B)	J9	27	KH (B)	TB4	2					
2-1	LVR/B	12AWG	ET100	EYJ (B)	J9	20	KH (B)	TB4	3	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	NB18	HC (B)	V3	B	KB (B)	NB AUX.	11	48A	9-3.25	C4	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	NB8-4	EYJ (B)	J11	i	KB (B)	TB5	1	27D	7-3.75	B4	ELECTRICAL T/L CONNECTION	SEE SH. 27B (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	SPARE46	EYJ (B)	J12	g	FV (B)	/	/	/	/	/	/	
2-1	LVR/B	16AWG	SPARE48	EYJ (B)	J12	i	FV (B)	/	/	/	/	/	/	
2-1	LVR/B	16AWG	SPARE49	EYJ (B)	J12	j	FV (B)	/	/	/	/	/	/	
2-1	LVR/B	16AWG	SPARE50	EYJ (B)	J12	k	FV (B)	/	/	/	/	/	/	
2-1	LVR/B	2X12AWG	TH-126	EYJ (B)	J9	3	KH (B)	/	/	51D	7-3.141	D4	ELECTRICAL T/L CONNECTION	SEE SH. 51A (PAGE 7-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	2X16AWG	TH-130	EYJ (B)	J11	AM	KQ (B)	TB4	8	42C	7-3.113	B5	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	2X16AWG	TH-133	EYJ (B)	J12	F	AC (B)	A1-P1	V	42C	7-3.113	C4	ELECTRICAL T/L CONNECTION	SEE SH. 42B (PAGE 7-3.111 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	2X16AWG	TH-136	EYJ (B)	J12	C	AC (B)	A1-P1	W					
2-1	LVR/B	2X12AWG	TH-72	EYJ (B)	J9	23	KQ (B)	TB9	21	29A	7-3.81	B5	ELECTRICAL T/L CONNECTION	SEE SH. 29 (PAGE 7-3.79 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	2X12AWG	TH-80	EYJ (B)	J8	6	KH (B)	TB5	19	16	7-3.33	D5	ELECTRICAL T/L CONNECTION	
2-1	LVR/B	2X12AWG	TH-83	EYJ (B)	J8	6	KH (B)	TB5	7					
2-1	LVR/B	2X16AWG	TH-98	EYJ (B)	J12	z	PA (B)	/	/	51E	7-3.143	G3	ELECTRICAL T/L CONNECTION	SEE SH. 51B (PAGE 7-3.137 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: ROOF	REV. 00 Page 33 of 33

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-1	LVR/B	16AWG	X16-8	EYJ (B)	J11	F	KQ (B)	TB6	1	43A	7-3.117	D4	ELECTRICAL T/L CONNECTION	SEE SH. 43 (PAGE 7-3.115 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	14AWG	X18-4	HC (B)	V3	J	KQ (B)	TB5	10	48A	9-3.25	C4	SYTRONIC CONTROL	SEE SH. 48 (PAGE 9-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	X19-4	EYJ (B)	J12	f	KQ (B)	TB6	23	47A	7-3.129	B5	ELECTRICAL T/L CONNECTION	SEE SH. 47 (PAGE 7-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-1	LVR/B	16AWG	X29-34	EYJ (B)	J11	AP	FV (B)	TB1	20	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)



Location Illustration Code: 2-2

Figure 11-1.17 Raceway Location - "A" Body Section - RH Side

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 1 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	CRT/01-03	16AWG	18MA-5	DR3 (A)	/	2	DF3 (A)	/	2	21G	8-3.41	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/01-03	16AWG	18MB-6	DR3 (A)	/	1	DF3 (A)	/	1					
2-2	CRT/01-03	16AWG	18MB-7	DR3 (A)	/	1	DR3 (A)	/	3					
2-2	CRT/01-03	16AWG/TH02	35AA-3	CH (A)	/	2	CH (A)	TB	2	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/01-03	16AWG/TH02	35BA-3	CH (A)	/	1	CH (A)	TB	1					
2-2	CRT/01-03	16AWG	NB37-16	DR3 (A)	/	4	DO (A)	A3TB	31	21G	8-3.41	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/01-03	16AWG	NB37-17	DR3 (A)	/	4	DM3 (A)	/	22					
2-2	CRT/01-03	2X16AWG	TH-02	CH (A)	/	/	CH (A)	TB	3	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/01-08	16AWG	17NA-3	DR5 (A)	/	2	DF5 (A)	/	2	21G	8-3.41	D4	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/01-08	16AWG	17NB-3	DR5 (A)	/	1	DF5 (A)	/	1					
2-2	CRT/01-08	16AWG	17NB-4	DR5 (A)	/	3	DR5 (A)	/	1					
2-2	CRT/01-08	16AWG	NB37-5	DR5 (A)	/	4	DA5 (A)	/	2					
2-2	CRT/01-10	16AWG	17NA-5	DR7 (A)	/	2	DF7 (A)	/	2	21G	8-3.41	C2		
2-2	CRT/01-10	16AWG	17NB-6	DR7 (A)	/	1	DF7 (A)	/	1					
2-2	CRT/01-10	16AWG	17NB-7	DR7 (A)	/	1	DR7 (A)	/	3					
2-2	CRT/01-10	16AWG	NB37-27	DR7 (A)	/	4	DO (A)	A7TB	31					
2-2	CRT/02-02	16AWG	18JA-6	DK3 (A)	/	16	DO (A)	A3TB	13	21G	8-3.41	D6	INTERNAL DOOR CREW SWITCH	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-02	16AWG	18JA-8	DK3 (A)	/	25	DM3 (A)	/	25					
2-2	CRT/02-02	16AWG	18JB-2	DK3 (A)	/	17	DM3 (A)	/	17					
2-2	CRT/02-02	16AWG	18JC-1	DK3 (A)	/	12	DM3 (A)	/	12					
2-2	CRT/02-02	16AWG	18JD-2	DK3 (A)	/	24	DM3 (A)	/	24					
2-2	CRT/02-02	16AWG	18JE-1	DK3 (A)	/	21	DM3 (A)	/	21					
2-2	CRT/02-02	16AWG	36QA-1	CI (A)	TB	2	CW (A)	TB3	16	31A	11-3.35	G5	INTERCOM UNIT PASS ENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-02	16AWG	36RA-1	CI (A)	TB	1	CW (A)	TB3	17					
2-2	CRT/02-02	16AWG	48AG-4	LM1 (A)	L1	1	LM1 (A)	L2	1	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 2 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	CRT/02-02	16AWG/TH29	ET084-2	CI (A)	TB	4	CW (A)	TB3	19	31A	11-3.35	G5	INTERCOM UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-02	16AWG/TH29	ET085-2	CI (A)	TB	3	CW (A)	TB3	18					
2-2	CRT/02-02	16AWG	NB54-15	LM1 (A)	L1	2	LM1 (A)	L2	2	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-02	2X16AWG	TH-29	CI (A)	TB	5	CW (A)	TB3	20	31A	11-3.35	G5	INTERCOM UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-04	16AWG	18JA-8	DM3 (A)	/	25	DK3 (A)	/	25	21G	8-3.41	C6	EXTERNAL DOOR CREW SWITCH	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-04	16AWG	18JB-2	DM3 (A)	/	17	DK3 (A)	/	17					
2-2	CRT/02-04	16AWG	18JB-3	DM3 (A)	/	17	DO (A)	A3TB	15					
2-2	CRT/02-04	16AWG	18JC-1	DM3 (A)	/	12	DK3 (A)	/	12					
2-2	CRT/02-04	16AWG	18JD-2	DM3 (A)	/	24	DK3 (A)	/	24					
2-2	CRT/02-04	16AWG	18JD-3	DM3 (A)	/	24	DO (A)	A3TB	14					
2-2	CRT/02-04	16AWG	18JE-1	DM3 (A)	/	21	DK3 (A)	/	21					
2-2	CRT/02-04	16AWG	NB37-17	DM3 (A)	/	22	DR3 (A)	/	4					
2-2	CRT/02-06	16AWG	17NA-2	DF5 (A)	/	2	DO (A)	A5TB	25	21G	8-3.41	D4	INTERNAL PASSENGER PUSHBUTTON	
2-2	CRT/02-06	16AWG	17NB-2	DF5 (A)	/	1	LX5 (A)	/	1					
2-2	CRT/02-06	16AWG	46MA-4	NB2 (A)	/	1	KQ (A)	TB6	6	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-06	16AWG	46MA-6	NB2 (A)	/	3	NB1 (A)	/	1					
2-2	CRT/02-06	16AWG	48AG-6	LM5 (A)	L1	1	LM5 (A)	L2	1	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-06	16AWG	NB37-5	DR5 (A)	/	4	DA5 (A)	/	2	21G	8-3.41	D4	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-06	16AWG	NB54-12	LM5 (A)	L1	2	LM5 (A)	L2	2	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 3 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	CRT/02-06	16AWG	X16-11	NB2 (A)	/	4	NB1 (A)	/	2	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-06	16AWG	X16-7	NB2 (A)	/	2	KQ (A)	TB6	7					
2-2	CRT/02-07	16AWG	14BA-4	SA5 (A)	TB	15	SC5 (A)	TB	1	22D	8-3.51	D5	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-07	16AWG	14BB-1	SA5 (A)	TB	16	SC5 (A)	TB	2					
2-2	CRT/02-07	16AWG	14BC-3	SA5 (A)	TB	8	SC5 (A)	TB	5					
2-2	CRT/02-07	16AWG	14CA-4	SA5 (A)	TB	13	SC5 (A)	TB	3					
2-2	CRT/02-07	16AWG	14CB-1	SA5 (A)	TB	14	SC5 (A)	TB	4					
2-2	CRT/02-07	16AWG	17QA-2	SA5 (A)	TB	4	DO (A)	A7TB	22	21G	8-3.41	D2	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-07	12AWG	ET005-4	SA5 (A)	TB	5	SA1 (A)	TB	5	22C	8-3.49	D5	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-07	12AWG	ET005-5	SA5 (A)	TB	5	EYP (A)	P7	24					
2-2	CRT/02-07	12AWG	ET006-4	SA5 (A)	TB	6	SA1 (A)	TB	6					
2-2	CRT/02-07	12AWG	ET006-5	SA5 (A)	TB	6	EYP (A)	P7	23					
2-2	CRT/02-09	16AWG	17NA-4	DF7 (A)	/	2	DO (A)	A7TB	25	21G	8-3.41	C2	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-09	16AWG	17NB-5	DF7 (A)	/	1	DO (A)	A7TB	24					
2-2	CRT/02-09	16AWG	46MA-6	NB1 (A)	/	1	NB2 (A)	/	3	43A	8-3.75	B6	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-09	16AWG	48AG-5	LM5 (A)	L1	1	LE2 (A)	TB	4	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-09	16AWG	48AG-6	LM5 (A)	L1	1	LM5 (A)	L2	1					
2-2	CRT/02-09	16AWG	NB37-27	DR7 (A)	/	4	DO (A)	A7TB	31	21G	8-3.41	C2	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-09	16AWG	NB54-11	LM5 (A)	L1	2	LE2 (A)	TB	2	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-09	16AWG	NB54-12	LM5 (A)	L1	2	LM5 (A)	L2	2					
2-2	CRT/02-09	16AWG	X16-11	NB1 (A)	/	2	NB2 (A)	/	4	43A	8-3.75	B6	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 4 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	CRT/03-05	16AWG	66BD-2	DN (A)	/	1	DN (A)	TB	1	32A	8-3.71	D6	PASSENGER EMERGENCY STOP	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/03-05	16AWG	66BE-1	DN (A)	/	2	DN (A)	TB	3					
2-2	CRT/03-05	16AWG	ET048-10	DN (A)	/	-	KQ (A)	TLN2	/					
2-2	CRT/03-05	16AWG	ET063-4	DN (A)	/	3	DN (A)	TB	2					
2-2	CRT/03-05	16AWG	ET063-6	DN (A)	/	3	DN (A)	/	+					
2-2	CRT/03-05	16AWG	ET069-15	DN (A)	/	4	KQ (A)	TLP1	/					
2-2	CRT/02-01	16AWG	18MA-4	DF3 (A)	/	2	DO (A)	A3TB	25	21G	8-3.41	D6	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-01	16AWG	18MB-5	DF3 (A)	/	1	DO (A)	A3TB	24					
2-2	CRT/02-01	16AWG/TH02	35AA-3	CH (A)	/	2	CH (A)	TB	2	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-01	16AWG/TH02	35BA-3	CH (A)	/	1	CH (A)	TB	1					
2-2	CRT/02-01	16AWG	NB37-16	DR3 (A)	/	4	DO (A)	A3TB	31	21G	8-3.41	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	CRT/02-01	2X16AWG	TH-02	CH (A)	/	/	CH (A)	TB	3	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	IVR/AR	14AWG	47AA-2	LA2 (A)	TB	2	BG (A)	TB1	5	26C	10-3.27	A5	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	IVR/AR	16AWG	47AA-3	LA2 (A)	TB	2	LA1 (A)	/	B					
2-2	IVR/AR	16AWG	47AA-4	LA2 (A)	/	B	LA2 (A)	TB	2					
2-2	IVR/AR	10AWG	70AC-3	KO (A)	1	1	KO (A)	2	1	40	5-3.151	D4	CONVENIENCE OUTLETS	
2-2	IVR/AR	6AWG	70AD-2	HC (A)	V2	C	BG (A)	TB2	3	40	9-3.19	C5	HVAC LOADS	
2-2	IVR/AR	12AWG	70AG-2	HQ (A)	TB1	2	BG (A)	TB1	1	40	9-3.19	D4	CAB HEATER	
2-2	IVR/AR	6AWG	71AD-2	HC (A)	V2	B	BG (A)	TB2	2	40	9-3.19	C5	HVAC LOADS	
2-2	IVR/AR	6AWG	72AD-2	HC (A)	V2	A	BG (A)	TB2	1					
2-2	IVR/AR	12AWG	72AG-2	HQ (A)	TB1	1	BG (A)	TB1	3	40	9-3.19	D4	CAB HEATER	
2-2	IVR/AR	14AWG	73AA-19	LA2 (A)	TB	1	LA5 (A)	TB	1	26C	10-3.27	A5	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	IVR/AR	16AWG	73AA-20	LA2 (A)	/	W	LA2 (A)	TB	1					
2-2	IVR/AR	16AWG	73AA-21	LA2 (A)	TB	1	LA1 (A)	/	W					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 5 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	IVR/AR	10AWG	73AA-3	KO (A)	1	2	KO (A)	2	2	40	5-3.151	D4	CONVENIENCE OUTLETS	
2-2	IVR/AR	14AWG	73AA-5	HC (A)	V2	D	BG (A)	TBN	6	40	9-3.19	C5	HVAC LOADS	
2-2	LVR/AR1	16AWG	17EA-10	DO (A)	A5TB	7	DO (A)	A7TB	7	21F	8-3.39	D5	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	17EA-8	DO (A)	A1TB	7	DO (A)	A3TB	7	21F	8-3.39	D6		
2-2	LVR/AR1	16AWG	17EA-8	DO (A)	A3TB	7	DO (A)	A1TB	7					
2-2	LVR/AR1	16AWG	17EA-9	DO (A)	A3TB	7	DO (A)	A5TB	7					
2-2	LVR/AR1	16AWG	17LE-1	DO (A)	A5TB	5	DO (A)	A7TB	4	21F	8-3.39	D5		
2-2	LVR/AR1	16AWG	17LF-1	DO (A)	A3TB	5	DO (A)	A5TB	4	21F	8-3.39	D6		
2-2	LVR/AR1	16AWG	17LG-1	DO (A)	A1TB	5	DO (A)	A3TB	4					
2-2	LVR/AR1	16AWG	17NA-1	DO (A)	A5TB	25	DO (A)	A7TB	25	21G	8-3.41	(CD)3	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	17NA-2	DO (A)	A5TB	25	DF5 (A)	/	2					
2-2	LVR/AR1	16AWG	17NA-4	DO (A)	A7TB	25	DF7 (A)	/	2					
2-2	LVR/AR1	16AWG	17NB-1	DO (A)	A5TB	24	DO (A)	A7TB	24					
2-2	LVR/AR1	16AWG	17NB-5	DO (A)	A7TB	24	DF7 (A)	/	1					
2-2	LVR/AR1	16AWG	17NB-8	DO (A)	A5TB	24	LX5 (A)	/	1					
2-2	LVR/AR1	16AWG	17PA-1	DO (A)	A5TB	27	DO (A)	A7TB	27					
2-2	LVR/AR1	16AWG	17PA-2	DO (A)	A5TB	27	DA5 (A)	/	1					
2-2	LVR/AR1	16AWG	17QA-1	DO (A)	A5TB	22	DO (A)	A7TB	22					
2-2	LVR/AR1	16AWG	17QA-2	DO (A)	A7TB	22	SA5 (A)	TB	4					
2-2	LVR/AR1	16AWG	17RA-1	DO (A)	A5TB	21	DO (A)	A7TB	21					
2-2	LVR/AR1	16AWG	17RA-2	DO (A)	A7TB	21	SD7 (A)	/	1					
2-2	LVR/AR1	16AWG	17TA-1	DO (A)	A5TB	17	DO (A)	A7TB	17					
2-2	LVR/AR1	16AWG	17UA-1	DO (A)	A5TB	28	DO (A)	A7TB	28					
2-2	LVR/AR1	16AWG	17UA-2	DO (A)	P7	3	DO (A)	A5TB	28					
2-2	LVR/AR1	16AWG	17UA-3	DO (A)	A7TB	28	DO (A)	P7-1	1					
2-2	LVR/AR1	16AWG	17VA-1	DO (A)	A7TB	29	DO (A)	P7-2	1					
2-2	LVR/AR1	16AWG	17VA-2	DO (A)	P7	1	DO (A)	A7TB	29					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 6 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR1	16AWG	17WA-1	DO (A)	A5TB	18	DO (A)	A7TB	18	21G	**8-3.41**	(CD)3	DOOR OPERATOR	SEE SH. 21C (PAGE **8-3.33** FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	12AWG	18DA-2	DO (A)	A5TB	1	DO (A)	A7TB	1	21E	8-3.37	D6	DOOR OPERATOR	SEE SH. 21A (PAGE 8-3.29FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	12AWG	18DA-3	DO (A)	A3TB	1	DO (A)	A5TB	1					
2-2	LVR/AR1	12AWG	18DA-4	DO (A)	A1TB	1	DO (A)	A3TB	1					
2-2	LVR/AR1	12AWG	18DA-5	DO (A)	A1TB	1	KR (A)	TB1	4					
2-2	LVR/AR1	12AWG	18EA-2	DO (A)	A5TB	2	DO (A)	A7TB	2					
2-2	LVR/AR1	12AWG	18EA-3	DO (A)	A3TB	2	DO (A)	A5TB	2					
2-2	LVR/AR1	12AWG	18EA-4	DO (A)	A1TB	2	DO (A)	A3TB	2					
2-2	LVR/AR1	12AWG	18EA-5	DO (A)	A1TB	2	KR (A)	TB1	5					
2-2	LVR/AR1	12AWG	18FA-2	DO (A)	A5TB	3	DO (A)	A7TB	3					
2-2	LVR/AR1	12AWG	18FA-3	DO (A)	A3TB	3	DO (A)	A5TB	3					
2-2	LVR/AR1	12AWG	18FA-4	DO (A)	A1TB	3	DO (A)	A3TB	3					
2-2	LVR/AR1	12AWG	18FA-5	DO (A)	A1TB	3	KR (A)	TB1	6					
2-2	LVR/AR1	16AWG	18JA-1	DO (A)	A1TB	13	DO (A)	A3TB	13	21G	8-3.41	(CD)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	18JA-6	DO (A)	A3TB	13	DK3 (A)	/	16					
2-2	LVR/AR1	16AWG	18JB-3	DO (A)	A3TB	15	DM3 (A)	/	17					
2-2	LVR/AR1	16AWG	18JB-4	DO (A)	A1TB	15	DO (A)	A3TB	15					
2-2	LVR/AR1	16AWG	18JD-3	DO (A)	A3TB	14	DM3 (A)	/	24					
2-2	LVR/AR1	16AWG	18JD-4	DO (A)	A1TB	14	DO (A)	A3TB	14					
2-2	LVR/AR1	16AWG	18KA-1	DO (A)	A1TB	20	DO (A)	A3TB	20					
2-2	LVR/AR1	16AWG	18LA-1	DO (A)	A1TB	19	DO (A)	A3TB	19					
2-2	LVR/AR1	16AWG	18MA-1	DO (A)	A1TB	25	DO (A)	A3TB	25					
2-2	LVR/AR1	16AWG	18MA-2	DO (A)	A1TB	25	DF1 (A)	/	2					
2-2	LVR/AR1	16AWG	18MA-4	DO (A)	A3TB	25	DF3 (A)	/	2					
2-2	LVR/AR1	16AWG	18MB-1	DO (A)	A1TB	24	DO (A)	A3TB	24					
2-2	LVR/AR1	16AWG	18MB-2	DO (A)	A1TB	24	DF1 (A)	/	1					
2-2	LVR/AR1	16AWG	18MB-5	DO (A)	A3TB	24	DF3 (A)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "A" BODY SECTION RH SIDE		REV. 00 Page 7 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR1	16AWG	18MB-8	DO (A)	A1TB	24	LX1 (A)	/	1	21G	8-3.41	(CD)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	18PA-1	DO (A)	A1TB	18	DO (A)	A3TB	18					
2-2	LVR/AR1	16AWG	18QA-1	DO (A)	A1TB	17	DO (A)	A3TB	17					
2-2	LVR/AR1	16AWG	18RA-1	DO (A)	A1TB	16	DO (A)	A3TB	16					
2-2	LVR/AR1	16AWG	18SA-1	DO (A)	A1TB	11	DO (A)	A3TB	11					
2-2	LVR/AR1	16AWG	18TA-1	DO (A)	A1TB	27	DO (A)	A3TB	27					
2-2	LVR/AR1	16AWG	18TA-2	DO (A)	A1TB	27	DA1 (A)	/	1					
2-2	LVR/AR1	16AWG	18UA-1	DO (A)	A1TB	28	DO (A)	A3TB	28					
2-2	LVR/AR1	16AWG	18UA-2	DO (A)	P3	3	DO (A)	A1TB	28					
2-2	LVR/AR1	16AWG	18UA-3	DO (A)	A3TB	28	DO (A)	P3-1	1					
2-2	LVR/AR1	16AWG	18WA-1	DO (A)	A1TB	21	DO (A)	A3TB	21					
2-2	LVR/AR1	16AWG	18WA-2	DO (A)	A3TB	21	SD3 (A)	/	2					
2-2	LVR/AR1	16AWG	18XA-1	DO (A)	A1TB	22	DO (A)	A3TB	22					
2-2	LVR/AR1	16AWG	18XA-2	DO (A)	A3TB	22	SA1 (A)	TB	4					
2-2	LVR/AR1	16AWG	18YA-1	DO (A)	P3	1	DO (A)	A3TB	29					
2-2	LVR/AR1	16AWG	18YA-3	DO (A)	A3TB	29	DO (A)	P3-2	1					
2-2	LVR/AR1	16AWG	19XA-1	DO (A)	A1TB	40	DV1 (A)	/	1					
2-2	LVR/AR1	16AWG	19ZA-1	DO (A)	A3TB	40	DV3 (A)	/	1					
2-2	LVR/AR1	14AWG	48AA-11	DO (A)	A3TB	32	LE2 (A)	TB	3	26D	8-3.59	B6	DOOR OPERATOR	SEE SH. 26B (PAGE 8-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	48AA-20	DO (A)	A1TB	32	DO (A)	A3TB	32	26D	8-3.59	A6		
2-2	LVR/AR1	16AWG	48AB-20	DO (A)	A3TB	33	LE1 (A)	TB	2	26D	8-3.59	B6		
2-2	LVR/AR1	16AWG	48AB-6	DO (A)	A1TB	33	LE1 (A)	TB	2	26D	8-3.59	A6		
2-2	LVR/AR1	16AWG	48AG-3	LE2 (A)	TB	4	LM1 (A)	L1	1	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-2	LVR/AR1	16AWG	48AG-5	LE2 (A)	TB	4	LM5 (A)	L1	1					
2-2	LVR/AR1	16AWG/TH59	49AA-3	KX (A)	TB1	1	KG (A)	TB1	1	35	12-3.33	B(5-6)	SIDE DESTINATION SIGN	
2-2	LVR/AR1	16AW/TH143	49AA-9	KX (A)	TB1	11	AW (A)	TB7	9					
2-2	LVR/AR1	16AWG/TH59	49BA-3	KX (A)	TB1	2	KG (A)	TB1	2					
2-2	LVR/AR1	16AW/TH143	49BA-9	KX (A)	TB1	12	AW (A)	TB7	10					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 8 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR1	16AWG	51AB-1	KX (A)	/	Y	LC (A)	/	Y	26C	12-3.27	B7	SIDE DESTINATION SIGN	SEE SH. 26A (PAGE 12-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	51AC-1	KX (A)	/	Y	LC (A)	/	Y					
2-2	LVR/AR1	16AWG	51AD-1	KX (A)	/	B	LC (A)	/	B					
2-2	LVR/AR1	16AWG	51AE-1	KX (A)	/	B	LC (A)	/	B					
2-2	LVR/AR1	16AWG	51AG-1	KY (A)	/	R	LC (A)	/	R					
2-2	LVR/AR1	16AWG	51AH-1	KY (A)	/	R	LC (A)	/	R					
2-2	LVR/AR1	16AWG	51AJ-1	KY (A)	/	Y	LC (A)	/	Y					
2-2	LVR/AR1	16AWG	51AK-1	KY (A)	/	Y	LC (A)	/	Y					
2-2	LVR/AR1	16AWG	61AA-5	DP (A)	A1TB	12	DP (A)	A5TB	12	32A	8-3.71	D6	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	12AWG	66BD-1	DN (A)	TB	1	DP (A)	A1TB	9					
2-2	LVR/AR1	12AWG	66BE-2	DN (A)	TB	3	DP (A)	A5TB	8					
2-2	LVR/AR1	12AWG	66BF-1	DP (A)	A5TB	9	AA (A)	P4	M	32A	8-3.71	D5		
2-2	LVR/AR1	16AWG	ET063-7	DN (A)	TB	4	AA (A)	P3	j	32A	8-3.71	D6		
2-2	LVR/AR1	16AWG	NB27-3	KX (A)	TB1	4	KG (A)	TB1	4	35	12-3.33	B(5-6)	SIDE DESTINATION SIGN	
2-2	LVR/AR1	16AWG	NB37-16	DO (A)	A3TB	31	DR3 (A)	/	4	21G	8-3.41	(CD)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	NB37-19	DO (A)	P3	2	DO (A)	A3TB	31					
2-2	LVR/AR1	16AWG	NB37-23	DO (A)	A7TB	23	DO (A)	P7-2	2	21G	8-3.41	(CD)3		
2-2	LVR/AR1	16AWG	NB37-24	DO (A)	A7TB	20	DO (A)	P7-1	2					
2-2	LVR/AR1	16AWG	NB37-27	DO (A)	A7TB	31	DR7 (A)	/	4					
2-2	LVR/AR1	16AWG	NB37-3	DO (A)	A5TB	31	DA5 (A)	/	2					
2-2	LVR/AR1	16AWG	NB37-32	DO (A)	A5TB	20	DO (A)	A7TB	20					
2-2	LVR/AR1	16AWG	NB37-33	DO (A)	A5TB	19	DO (A)	A7TB	19					
2-2	LVR/AR1	16AWG	NB37-34	DO (A)	A5TB	15	DO (A)	A7TB	15					
2-2	LVR/AR1	16AWG	NB37-35	DO (A)	A5TB	14	DO (A)	A7TB	14					
2-2	LVR/AR1	16AWG	NB37-37	DO (A)	A3TB	23	DO (A)	P3-2	2	21G	8-3.41	(CD)7		
2-2	LVR/AR1	16AWG	NB37-38	DO (A)	P7	2	DO (A)	A7TB	20					
2-2	LVR/AR1	16AWG	NB37-4	DO (A)	A1TB	23	DO (A)	A3TB	23					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "A" BODY SECTION RH SIDE		REV. 00 Page 9 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR1	16AWG	NB37-40	DO (A)	A1TB	31	LX1 (A)	/	2	21G	8-3.41	(CD)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	NB37-41	DO (A)	A5TB	31	LX5 (A)	/	2	21G	8-3.41	(CD)3		
2-2	LVR/AR1	16AWG	NB37-50	DO (A)	A3TB	23	SD3 (A)	/	1	21G	8-3.41	(CD)7		
2-2	LVR/AR1	16AWG	NB37-51	DO (A)	A7TB	23	SD7 (A)	/	2	21G	8-3.41	(CD)3		
2-2	LVR/AR1	16AWG	NB37-53	DO (A)	A1TB	26	DO (A)	A3TB	26	21G	8-3.41	(CD)7		
2-2	LVR/AR1	16AWG	NB37-55	DO (A)	A5TB	26	DO (A)	A7TB	26	21G	8-3.41	(CD)3		
2-2	LVR/AR1	16AWG	NB37-9	DO (A)	A5TB	23	DO (A)	A7TB	23					
2-2	LVR/AR1	16AWG	NB54-11	LE2 (A)	TB	2	LM5 (A)	L1	2	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	NB54-13	LE1 (A)	TB	1	LM1 (A)	L1	2					
2-2	LVR/AR1	14AWG	NB54-9	LE1 (A)	TB	1	LE2 (A)	TB	2					
2-2	LVR/AR1	16AWG	S37-5	DO (A)	A5TB	10	DO (A)	A7TB	10	21G	8-3.41	(CD)3	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	16AWG	S37-6	DO (A)	A1TB	10	DO (A)	A3TB	10	21G	8-3.41	(CD)7		
2-2	LVR/AR1	16AWG	S40-8	DO (A)	A1TB	4	KR (A)	TB4	8	21F	8-3.39	D6	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR1	2X16AWG	TH-143	KX (A)	TB1	13	AW (A)	TB7	11	35	12-3.33	B(5-6)	SIDE DESTINATION SIGN	
2-2	LVR/AR1	2X16AWG	TH-59	KX (A)	TB1	5	KG (A)	TB1	5					
2-2	LVR/AR1	16AWG	X27-5	KX (A)	TB1	3	KG (A)	TB1	3					
2-2	LVR/AR2	16AWG	14BA-1	SC1 (A)	TB	2	SA1 (A)	TB	16	22D	8-3.51	D7	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	12AWG	14BA-2	SC5 (A)	TB	1	SC1 (A)	TB	2	22D	8-3.51	D6		
2-2	LVR/AR2	16AWG	14BA-4	SC5 (A)	TB	1	SA5 (A)	TB	15					
2-2	LVR/AR2	16AWG	14BB-1	SC5 (A)	TB	2	SA5 (A)	TB	16					
2-2	LVR/AR2	16AWG	14BC-1	SC1 (A)	TB	5	SA1 (A)	TB	8	22D	8-3.51	D7		
2-2	LVR/AR2	16AWG	14BC-2	SC5 (A)	TB	5	SC1 (A)	TB	5	22D	8-3.51	D6		
2-2	LVR/AR2	16AWG	14BC-5	SC1 (A)	TB	5	KQ (A)	TB8	10	22D	8-3.51	D7		
2-2	LVR/AR2	16AWG	14CA-1	SC1 (A)	TB	4	SA1 (A)	TB	14					
2-2	LVR/AR2	12AWG	14CA-2	SC5 (A)	TB	3	SC1 (A)	TB	4	22D	8-3.51	D6		
2-2	LVR/AR2	16AWG	14CA-4	SC5 (A)	TB	3	SA5 (A)	TB	13					
2-2	LVR/AR2	16AWG	14CB-1	SC5 (A)	TB	4	SA5 (A)	TB	14					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 10 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR2	16AWG	17EA-2	DO (A)	A1TB	7	KQ (A)	TB9	23	21F	8-3.39	D6	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	17GA-2	AA (A)	P9	J	KR (A)	TB4	4	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	17HA-2	AA (A)	P9	K	KR (A)	TB4	3					
2-2	LVR/AR2	16AWG	18AA-14	AA (A)	P2	b	KR (A)	TB1	7					
2-2	LVR/AR2	16AWG	18BA-15	AA (A)	P2	c	KR (A)	TB1	8					
2-2	LVR/AR2	16AWG	18DA-13	AA (A)	P2	d	KR (A)	TB1	4					
2-2	LVR/AR2	16AWG	18EA-15	AA (A)	P2	e	KR (A)	TB1	5					
2-2	LVR/AR2	16AWG	18MA-4	DF3 (A)	/	2	DO (A)	A3TB	25	21G	8-3.41	D6	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	18MB-5	DF3 (A)	/	1	DO (A)	A3TB	24					
2-2	LVR/AR2	16AWG	18NA-1	SC1 (A)	TB	10	DO (A)	A3TB	30					
2-2	LVR/AR2	16AWG	18NB-2	SC1 (A)	TB	11	SA1 (A)	TB	1					
2-2	LVR/AR2	16AWG/TH02	35AA-3	CH (A)	/	2	CH (A)	TB	2	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG/TH02	35BA-3	CH (A)	/	1	CH (A)	TB	1					
2-2	LVR/AR2	16AWG	35KA-3	AA (A)	P4	h	KR (A)	TB2	18	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	46MA-4	NB2 (A)	/	1	KQ (A)	TB6	6	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	46MA-6	NB1 (A)	/	1	NB2 (A)	/	3	43A	8-3.75	B6		
2-2	LVR/AR2	16AWG	48AB-5	LE1 (A)	TB	2	KQ (A)	TB5	1	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	48AG-2	LE2 (A)	TB	4	KQ (A)	TB1	23					
2-2	LVR/AR2	16AWG	48AG-6	LM5 (A)	L1	1	LM5 (A)	L2	1	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	61AA-2	DP (A)	A1TB	12	KQ (A)	TB7	11	32A	8-3.71	D6	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 11 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR2	12AWG	ET005-4	SA1 (A)	TB	5	SA5 (A)	TB	5	22C	8-3.49	D6	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	12AWG	ET006-4	SA1 (A)	TB	6	SA5 (A)	TB	6					
2-2	LVR/AR2	12AWG	ET010	SC1 (A)	TB	3	KH (A)	TB6	23	22D	8-3.51	D7	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	ET010-3	SC1 (A)	TB	3	SA1 (A)	TB	13					
2-2	LVR/AR2	12AWG	ET011	SC1 (A)	TB	1	KH (A)	TB6	20					
2-2	LVR/AR2	16AWG	ET011-3	SC1 (A)	TB	1	SA1 (A)	TB	15					
2-2	LVR/AR2	16AWG	ET048-10	DN (A)	/	-	KQ (A)	TLN2	/	32A	8-3.71	D6	PASSENGER EMERGENCY STOP	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	ET069-15	DN (A)	/	4	KQ (A)	TLP1	/					
2-2	LVR/AR2	16AWG	ET101-3	AA (A)	P3	m	KR (A)	TB4	11	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	NB11-4	LC (A)	/	-	KB (A)	TB3	12	26C	10-3.29	C7	DESTINATION SIGN LIGHT BALLAST	SEE SH. 26A (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	10AWG	NB37	SC1 (A)	TB	13	KB (A)	TB8	4	21G	8-3.41	D6	CUT OUT SWITCH PANEL	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	12AWG	NB37-1	SC1 (A)	TB	9	DO (A)	A5TB	23					
2-2	LVR/AR2	16AWG	NB37-15	SC1 (A)	TB	9	SA1 (A)	TB	2					
2-2	LVR/AR2	16AWG	NB37-16	DR3 (A)	/	4	DO (A)	A3TB	31					
2-2	LVR/AR2	12AWG	NB37-2	SC1 (A)	TB	9	DO (A)	A1TB	23					
2-2	LVR/AR2	16AWG	NB37-21	SC1 (A)	TB	13	DO (A)	P3-1	2					
2-2	LVR/AR2	16AWG	NB37-6	DO (A)	A1TB	31	KB (A)	TB4	4	21G	8-3.41	(CD)7	DOOR OPERATOR	
2-2	LVR/AR2	16AWG	NB54-12	LM5 (A)	L1	2	LM5 (A)	L2	2	26D	10-3.29	A6	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	NB54-15	LM1 (A)	L1	2	LM1 (A)	L2	2					
2-2	LVR/AR2	16AWG	NB99-4	LZ (A)	L2	1	KQ (A)	TB10	21	50A	10-3.43	A6	TROUBLE LIGHT	
2-2	LVR/AR2	10AWG	S37-2	SC1 (A)	TB	8	KB (A)	TB9	2	21G	8-3.41	D6	CUT OUT SWITCH PANEL	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	12AWG	S37-3	SC1 (A)	TB	8	DO (A)	A5TB	10					
2-2	LVR/AR2	12AWG	S37-4	SC1 (A)	TB	8	DO (A)	A1TB	10					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION RH SIDE	REV. 00 Page 12 of 12

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-2	LVR/AR2	2X16AWG	TH-02	CH (A)	/	/	CH (A)	TB	3	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	X16-11	NB1 (A)	/	2	NB2 (A)	/	4	43A	8-3.75	B6	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-2	LVR/AR2	16AWG	X16-7	NB2 (A)	/	2	KQ (A)	TB6	7	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)

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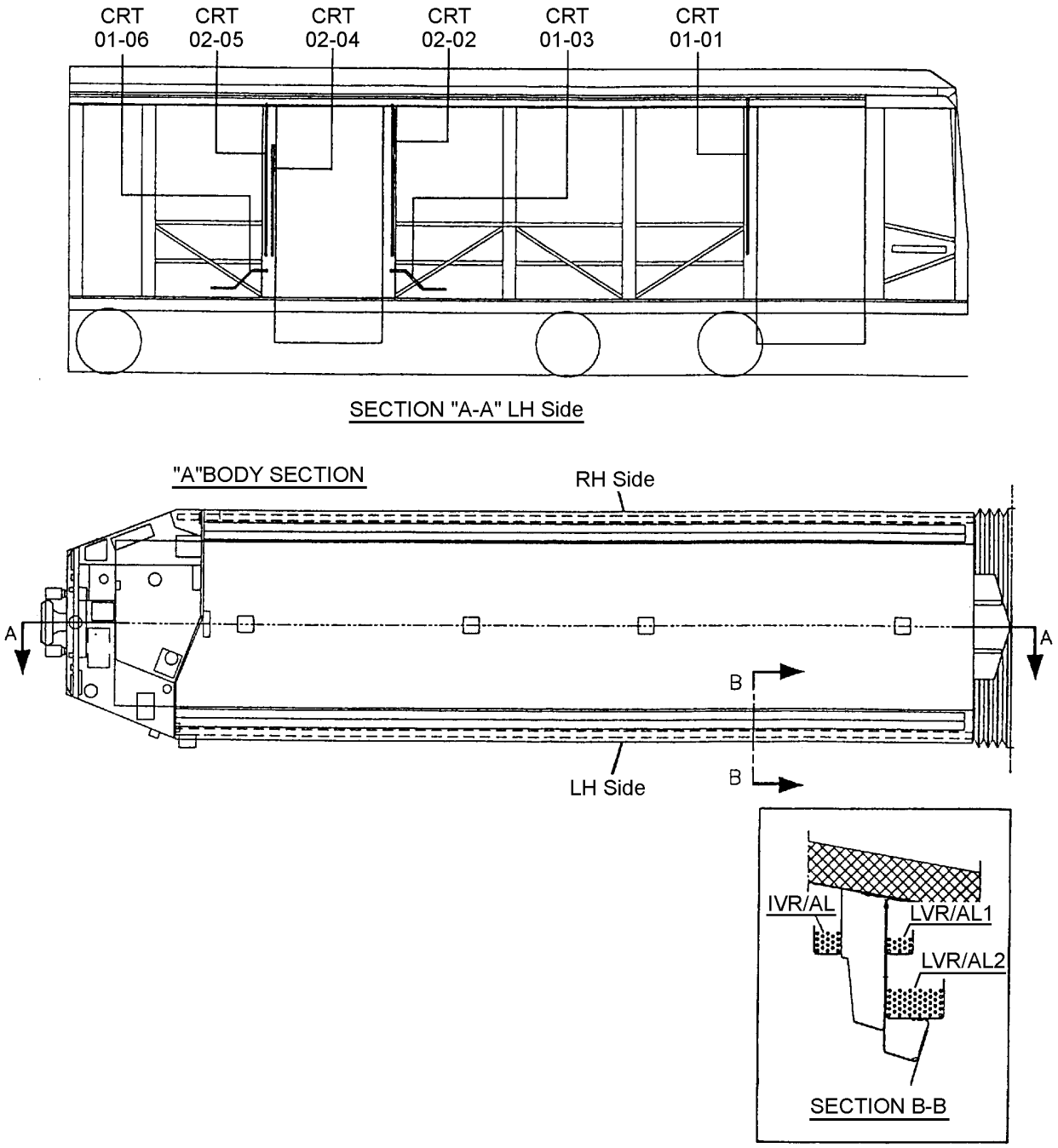


Location Illustration Code: 2-3

Figure 11-1.18 Raceway Location - "A" Body Section - LH Side

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 1 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	CRT/01-03	16AWG	19KA-3	DR4 (A)	/	2	DF4 (A)	/	2	21G	8-3.41	B5	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/01-03	16AWG	19KB-3	DR4 (A)	/	1	DF4 (A)	/	1					
2-3	CRT/01-03	16AWG	19KB-4	DR4 (A)	/	1	DR4 (A)	/	3					
2-3	CRT/01-03	16AWG	NB36-4	DR4 (A)	/	4	DA4 (A)	/	2					
2-3	CRT/01-06	16AWG	19KA-5	DR6 (A)	/	2	DF6 (A)	/	2	21G	8-3.41	A3		
2-3	CRT/01-06	16AWG	19KB-6	DR6 (A)	/	1	DF6 (A)	/	1					
2-3	CRT/01-06	16AWG	19KB-7	DR6 (A)	/	1	DR6 (A)	/	3					
2-3	CRT/01-06	16AWG	NB36-24	DR6 (A)	/	4	DO (A)	A6TB	31					
2-3	CRT/02-01	16AWG	19AA-5	DK2 (A)	/	16	DO (A)	A2TB	13	21G	8-3.41	B6	INTERNAL DOOR CREW SWITCH	
2-3	CRT/02-01	16AWG	19AA-7	DK2 (A)	/	25	DM2 (A)	/	25					
2-3	CRT/02-01	16AWG	19DA-1	DF2 (A)	/	2	DO (A)	A2TB	25	21G	8-3.41	A7	INTERNAL PASSENGER PUSHBUTTON	
2-3	CRT/02-01	16AWG	19DB-1	DF2 (A)	/	1	DO (A)	A2TB	24					
2-3	CRT/02-01	16AWG	19JB-2	DK2 (A)	/	17	DM2 (A)	/	17	21G	8-3.41	B6	INTERNAL DOOR CREW SWITCH	
2-3	CRT/02-01	16AWG	19JC-1	DK2 (A)	/	12	DM2 (A)	/	12					
2-3	CRT/02-01	16AWG	19JD-2	DK2 (A)	/	24	DM2 (A)	/	24					
2-3	CRT/02-01	16AWG	19JE-1	DK2 (A)	/	21	DM2 (A)	/	21					
2-3	CRT/02-01	16AWG	48AE-4	LM2 (A)	/	1	LE4 (A)	TB	2	26D	10-3.29	A8	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-01	16AWG	NB54-5	LM2 (A)	/	2	LE4 (A)	TB	1					
2-3	CRT/02-02	16AWG	19KA-2	DF4 (A)	/	2	DO (A)	A4TB	25	21G	8-3.41	B5	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-02	16AWG	19KB-2	DF4 (A)	/	1	LX4 (A)	/	1					
2-3	CRT/02-02	16AWG	46MA-3	NB4 (A)	/	1	KQ (A)	TB6	6	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-02	16AWG	46MA-5	NB4 (A)	/	3	NB3 (A)	/	1					
2-3	CRT/02-02	16AWG	48AE-5	LM4 (A)	L1	1	LE3 (A)	TB	4	26D	10-3.29	A7	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-02	16AWG	48AE-6	LM4 (A)	L1	1	LM4 (A)	L2	1					
2-3	CRT/02-02	16AWG	NB36-4	DR4 (A)	/	4	DA4 (A)	/	2	21G	8-3.41	B5	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 2 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	CRT/02-02	16AWG	NB54-7	LM4 (A)	L1	2	LE3 (A)	TB	2	26D	10-3.29	A7	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-02	16AWG	NB54-8	LM4 (A)	L1	2	LM4 (A)	L2	2					
2-3	CRT/02-02	16AWG	X16-10	NB4 (A)	/	4	NB3 (A)	/	2	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-02	16AWG	X16-6	NB4 (A)	/	2	KQ (A)	TB6	7					
2-3	CRT/02-04	16AWG	14BE-4	SA4 (A)	TB	15	SC4 (A)	TB	1	22D	8-3.51	A5	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-04	16AWG	14BF-4	SA4 (A)	TB	13	SC4 (A)	TB	3					
2-3	CRT/02-04	16AWG	14BG-1	SA4 (A)	TB	14	SC4 (A)	TB	4					
2-3	CRT/02-04	16AWG	14BH-1	SA4 (A)	TB	16	SC4 (A)	TB	2					
2-3	CRT/02-04	16AWG	14CD-3	SA4 (A)	TB	8	SC4 (A)	TB	5					
2-3	CRT/02-04	16AWG	19SA-2	SA4 (A)	TB	4	DO (A)	A6TB	22	21G	8-3.41	B3	STEP MOVING EQUIPMENT	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-04	12AWG	ET007-3	SA4 (A)	TB	6	SA2 (A)	TB	6	22C	8-3.49	C5	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-04	12AWG	ET007-4	SA4 (A)	TB	6	EYP (A)	P7	25					
2-3	CRT/02-04	12AWG	ET008-3	SA4 (A)	TB	5	SA2 (A)	TB	5					
2-3	CRT/02-04	12AWG	ET008-4	SA4 (A)	TB	5	EYP (A)	P7	26					
2-3	CRT/02-05	16AWG	19KA-4	DF6 (A)	/	2	DO (A)	A6TB	25	21G	8-3.41	B4	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-05	16AWG	19KB-5	DF6 (A)	/	1	DO (A)	A6TB	24					
2-3	CRT/02-05	16AWG	46MA-5	NB3 (A)	/	1	NB4 (A)	/	3	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-05	16AWG	48AE-6	LM4 (A)	L1	1	LM4 (A)	L2	1	26D	10-3.29	A7	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-05	16AWG	NB36-24	DR6 (A)	/	4	DO (A)	A6TB	31	21G	8-3.41	A3	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	CRT/02-05	16AWG	NB54-8	LM4 (A)	L1	2	LM4 (A)	L2	2	26D	10-3.29	A7	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 3 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	CRT/02-05	16AWG	X16-10	NB3 (A)	/	2	NB4 (A)	/	4	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	IVR/AL	14AWG	47BA-2	LA5 (A)	TB	2	BG (A)	TB1	6÷7	26C	10-3.27	A7	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	IVR/AL	16AWG	47BA-5	LA4 (A)	TB	2	LA5 (A)	TB	2					
2-3	IVR/AL	16AWG	47BA-6	LA5 (A)	TB	2	LA5 (A)	BALLAST	B					
2-3	IVR/AL	16AWG	47BA-7	LA4 (A)	TB	2	LA3 (A)	/	B	26C	10-3.27	A6		
2-3	IVR/AL	16AWG	47BA-8	LA4 (A)	/	B	LA4 (A)	TB	2					
2-3	IVR/AL	16AWG	47BB-1	LA5 (A)	LAMP2	Y	LA5 (A)	BALLAST	Y	26C	10-3.27	A7		
2-3	IVR/AL	16AWG	47BC-1	LA5 (A)	LAMP2	Y	LA5 (A)	BALLAST	Y					
2-3	IVR/AL	16AWG	47BD-1	LA5 (A)	LAMP2	B	LA5 (A)	BALLAST	B					
2-3	IVR/AL	16AWG	47BE-1	LA5 (A)	LAMP2	B	LA5 (A)	BALLAST	B					
2-3	IVR/AL	16AWG	47BG-1	LA5 (A)	LAMP1	R	LA5 (A)	BALLAST	R					
2-3	IVR/AL	16AWG	47BH-1	LA5 (A)	LAMP1	R	LA5 (A)	BALLAST	R					
2-3	IVR/AL	16AWG	47BJ-1	LA5 (A)	LAMP1	Y	LA5 (A)	BALLAST	Y					
2-3	IVR/AL	16AWG	47BK-1	LA5 (A)	LAMP1	Y	LA5 (A)	BALLAST	Y					
2-3	IVR/AL	16AWG	73AA-14	LA5 (A)	TB	1	LA5 (A)	BALLAST	W					
2-3	IVR/AL	16AWG	73AA-15	LA4 (A)	TB	1	LA5 (A)	TB	1	26C	10-3.27	A4		
2-3	IVR/AL	16AWG	73AA-16	LA4 (A)	/	W	LA4 (A)	TB	1					
2-3	IVR/AL	16AWG	73AA-17	LA4 (A)	TB	1	LA3 (A)	/	W					
2-3	IVR/AL	14AWG	73AA-19	LA5 (A)	TB	1	LA2 (A)	TB	1	26C	10-3.27	A7		
2-3	IVR/AL	14AWG	73AA-4	LA5 (A)	TB	1	BG (A)	TBN	5					
2-3	LVR/AL1	16AWG	14BE-1	SC2 (A)	TB	2	SA2 (A)	TB	16	22D	8-3.51	A7	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	12AWG	14BE-2	SC4 (A)	TB	1	SC2 (A)	TB	2	22D	8-3.51	A6		
2-3	LVR/AL1	16AWG	14BE-4	SC4 (A)	TB	1	SA4 (A)	TB	15					
2-3	LVR/AL1	16AWG	14BF-1	SC2 (A)	TB	4	SA2 (A)	TB	14	22D	8-3.51	A7		
2-3	LVR/AL1	12AWG	14BF-2	SC4 (A)	TB	3	SC2 (A)	TB	4	22D	8-3.51	A6		
2-3	LVR/AL1	16AWG	14BF-4	SC4 (A)	TB	3	SA4 (A)	TB	13					
2-3	LVR/AL1	16AWG	14BG-1	SC4 (A)	TB	4	SA4 (A)	TB	14					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 4 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL1	16AWG	14BH-1	SC4 (A)	TB	2	SA4 (A)	TB	16	22D	8-3.51	A6	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	14CD-1	SC2 (A)	TB	5	SA2 (A)	TB	8	22D	8-3.51	A7		
2-3	LVR/AL1	16AWG	14CD-2	SC4 (A)	TB	5	SC2 (A)	TB	5	22D	8-3.51	A6		
2-3	LVR/AL1	16AWG	14CD-3	SC4 (A)	TB	5	SA4 (A)	TB	8					
2-3	LVR/AL1	16AWG	14CD-5	SC2 (A)	TB	5	KQ (A)	TB9	1	22D	8-3.51	A7		
2-3	LVR/AL1	16AWG	17EA-3	DO (A)	A2TB	7	KQ (A)	TB9	23	21F	8-3.39	C6	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	17XA-1	SC2 (A)	TB	10	DO (A)	A2TB	11	21G	8-3.41	B6	CUT OUT SWITCH PANEL	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	17XB-2	SC2 (A)	TB	11	SA2 (A)	TB	1					
2-3	LVR/AL1	16AWG	19CA-1	DO (A)	A2TB	19	AC (A)	A2-P2	Z	21G	8-3.41	(AB)7	DOOR OPERATOR	
2-3	LVR/AL1	16AWG	46MA-3	NB4 (A)	/	1	KQ (A)	TB6	6	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	47DA-3	LG1 (A)	/	1	KQ (A)	TB6	9	43A	10-3.41	B6	PASSENGER STOP REQUEST	
2-3	LVR/AL1	16AWG	47DA-4	LG2 (A)	/	1	KQ (A)	TB6	9	43A	10-3.41	B7		
2-3	LVR/AL1	16AWG	48AA-6	DO (A)	A2TB	32	KQ (A)	TB5	5	26D	8-3.41	B8	DOOR OPERATOR	SEE SH. 26B (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	48AB-2	DO (A)	A2TB	33	KQ (A)	TB5	1					
2-3	LVR/AL1	16AWG	48AE-2	LE3 (A)	TB	4	KQ (A)	TB1	17	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-3	LVR/AL1	16AWG	61AA-3	DP (A)	A2TB	12	KQ (A)	TB7	11	32A	8-3.71	C6	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	12AWG	ET009	SC2 (A)	TB	3	KH (A)	TB6	22	22D	8-3.51	A7	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	ET009-3	SC2 (A)	TB	3	SA2 (A)	TB	13					
2-3	LVR/AL1	12AWG	ET012	SC2 (A)	TB	1	KH (A)	TB6	21					
2-3	LVR/AL1	16AWG	ET012-3	SC2 (A)	TB	1	SA2 (A)	TB	15					
2-3	LVR/AL1	16AWG	NB16-2	LG1 (A)	/	2	KQ (A)	TB6	2	43A	10-3.41	B6	PASSENGER STOP REQUEST	SEE SH. 43 (PAGE 39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	16AWG	NB16-3	LG2 (A)	/	2	KQ (A)	TB6	2	43A	10-3.41	B7		

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 5 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL1	10AWG	NB36	SC2 (A)	TB	9	KB (A)	TB8	4	21G	8-3.41	B6	CUT OUT SWITCH PANEL	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	12AWG	NB36-1	SC2 (A)	TB	9	DO (A)	A4TB	23					
2-3	LVR/AL1	16AWG	NB36-17	SC2 (A)	TB	13	DO (A)	P2-1	2					
2-3	LVR/AL1	12AWG	NB36-2	SC2 (A)	TB	9	DO (A)	A2TB	23					
2-3	LVR/AL1	16AWG	NB36-5	SC2 (A)	TB	13	SA2 (A)	TB	2					
2-3	LVR/AL1	16AWG	NB36-8	SC2 (A)	TB	13	DR2 (A)	/	4					
2-3	LVR/AL1	16AWG	NB99-4	LZ (A)	L2	1	KQ (A)	TB10	21	50A	10-3.43	A6	TROUBLE LIGHT	
2-3	LVR/AL1	10AWG	S36-2	SC2 (A)	TB	8	KB (A)	TB9	1	21G	8-3.41	B6	CUT OUT SWITCH PANEL	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL1	12AWG	S36-3	SC2 (A)	TB	8	DO (A)	A4TB	10					
2-3	LVR/AL1	12AWG	S36-4	SC2 (A)	TB	8	DO (A)	A2TB	10					
2-3	LVR/AL1	16AWG	X16-6	NB4 (A)	/	2	KQ (A)	TB6	7	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	17EA-5	DO (A)	A2TB	7	DO (A)	A4TB	7	21F	8-3.39	C6	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	17EA-6	DO (A)	A4TB	7	DO (A)	A6TB	7					
2-3	LVR/AL2	16AWG	17MF-1	DO (A)	A4TB	5	DO (A)	A6TB	4					
2-3	LVR/AL2	16AWG	17MG-1	DO (A)	A2TB	5	DO (A)	A4TB	4					
2-3	LVR/AL2	16AWG	17YA-1	DO (A)	A2TB	22	SA2 (A)	TB	4	21G	8-3.41	(AB)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	17ZA-1	DO (A)	A2TB	27	DA2 (A)	/	1					
2-3	LVR/AL2	12AWG	18AA-3	DO (A)	A4TB	1	DO (A)	A6TB	1	21E	8-3.37	A6	DOOR OPERATOR	SEE SH. 21A (PAGE 8-3.29FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	12AWG	18AA-4	DO (A)	A2TB	1	DO (A)	A4TB	1	21E	8-3.37	A7		
2-3	LVR/AL2	12AWG	18AA-5	DO (A)	A2TB	1	KR (A)	TB1	7					
2-3	LVR/AL2	12AWG	18BA-3	DO (A)	A4TB	2	DO (A)	A6TB	2	21E	8-3.37	A6		
2-3	LVR/AL2	12AWG	18BA-4	DO (A)	A2TB	2	DO (A)	A4TB	2	21E	8-3.37	A7		
2-3	LVR/AL2	12AWG	18BA-5	DO (A)	A2TB	2	KR (A)	TB1	8					
2-3	LVR/AL2	12AWG	18CA-3	DO (A)	A4TB	3	DO (A)	A6TB	3	21E	8-3.37	A6		
2-3	LVR/AL2	12AWG	18CA-3	DO (A)	A6TB	3	DO (A)	A4TB	3					
2-3	LVR/AL2	12AWG	18CA-4	DO (A)	A2TB	3	DO (A)	A4TB	3					
2-3	LVR/AL2	12AWG	18CA-5	DO (A)	A2TB	3	KR (A)	TB1	9	21E	8-3.37	A7		

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 6 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL2	16AWG	19AA-5	DO (A)	A2TB	13	DK2 (A)	/	16	21G	8-3.41	(AB)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	19AA-7	DM2 (A)	/	25	DK2 (A)	/	25	21G	8-3.41	B6	EXTERNAL DOOR CREW SWITCH	
2-3	LVR/AL2	16AWG	19DA-1	DO (A)	A2TB	25	DF2 (A)	/	2	21G	8-3.41	(AB)7	DOOR OPERATOR	
2-3	LVR/AL2	16AWG	19DB-1	DO (A)	A2TB	24	DF2 (A)	/	1					
2-3	LVR/AL2	16AWG	19DB-4	DO (A)	A2TB	24	LX2 (A)	/	1					
2-3	LVR/AL2	16AWG	19EA-1	DO (A)	P2	3	DO (A)	A2TB	28					
2-3	LVR/AL2	16AWG	19EA-1	DO (A)	A2TB	28	DO (A)	P2	3					
2-3	LVR/AL2	16AWG	19EA-2	DO (A)	A2TB	28	DO (A)	P2-1	1					
2-3	LVR/AL2	16AWG	19FA-1	DO (A)	A2TB	21	SD2 (A)	/	1					
2-3	LVR/AL2	16AWG	19GA-1	DO (A)	P2	1	DO (A)	A2TB	18					
2-3	LVR/AL2	16AWG	19GA-3	DO (A)	A2TB	18	DO (A)	P2-2	1					
2-3	LVR/AL2	16AWG	19JB-2	DM2 (A)	/	17	DK2 (A)	/	17	21G	8-3.41	B6	EXTERNAL DOOR CREW SWITCH	
2-3	LVR/AL2	16AWG	19JB-3	DO (A)	A2TB	15	DM2 (A)	/	17	21G	8-3.41	(AB)7	DOOR OPERATOR	
2-3	LVR/AL2	16AWG	19JD-2	DM2 (A)	/	24	DK2 (A)	/	24	21G	8-3.41	B6	EXTERNAL DOOR CREW SWITCH	
2-3	LVR/AL2	16AWG	19JD-3	DO (A)	A2TB	14	DM2 (A)	/	24	21G	8-3.41	(AB)7	DOOR OPERATOR	
2-3	LVR/AL2	16AWG	19KA-1	DO (A)	A4TB	25	DO (A)	A6TB	25	21G	8-3.41	(AB)4		
2-3	LVR/AL2	16AWG	19KA-2	DO (A)	A4TB	25	DF4 (A)	/	2					
2-3	LVR/AL2	16AWG	19KA-4	DO (A)	A6TB	25	DF6 (A)	/	2					
2-3	LVR/AL2	16AWG	19KB-1	DO (A)	A4TB	24	DO (A)	A6TB	24					
2-3	LVR/AL2	16AWG	19KB-5	DO (A)	A6TB	24	DF6 (A)	/	1					
2-3	LVR/AL2	16AWG	19KB-8	DO (A)	A4TB	24	LX4 (A)	/	1					
2-3	LVR/AL2	16AWG	19LA-1	DO (A)	A4TB	18	DO (A)	A6TB	18					
2-3	LVR/AL2	16AWG	19MA-1	DO (A)	A4TB	17	DO (A)	A6TB	17					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 7 of 9

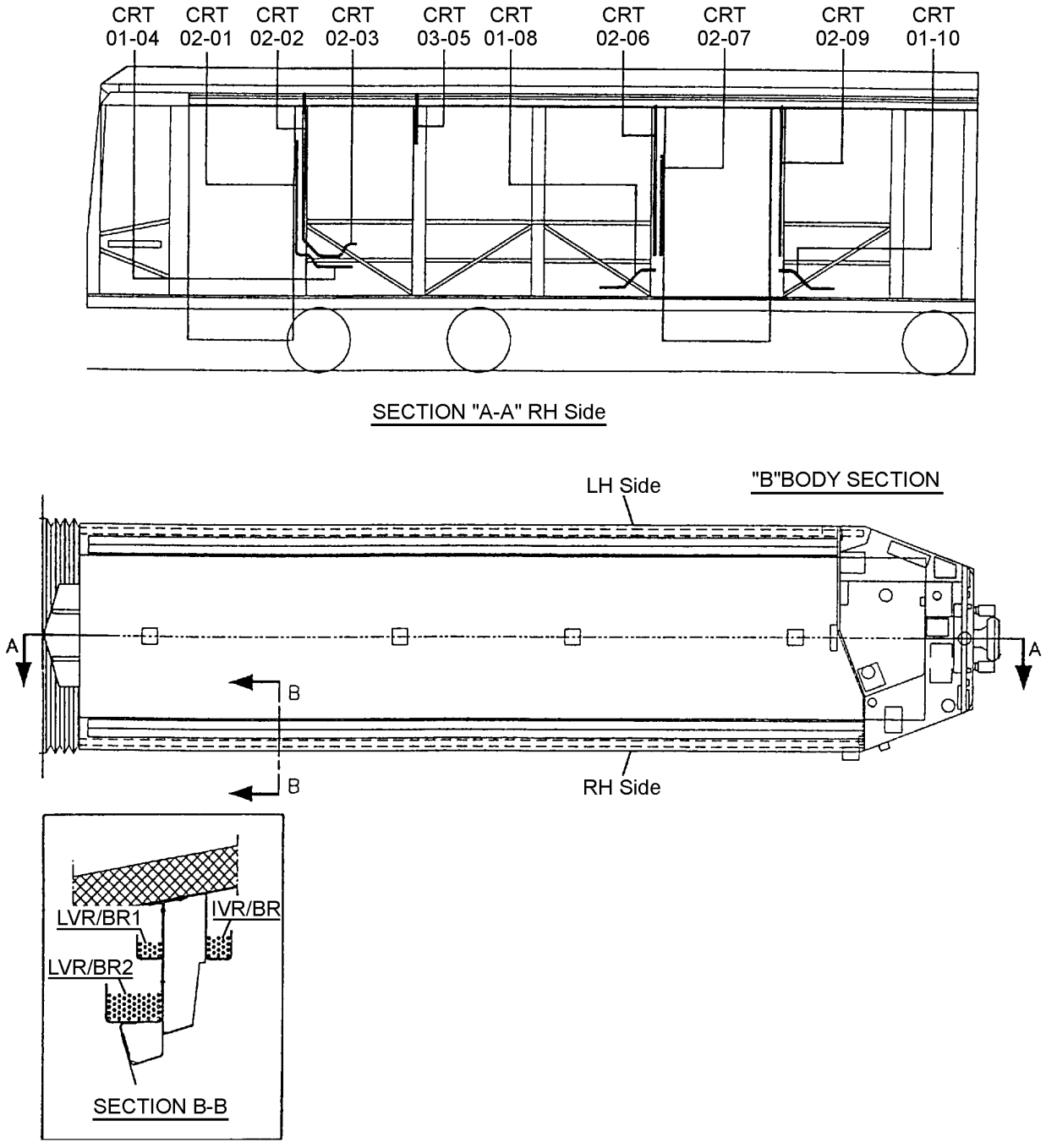
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL2	16AWG	19NA-1	DO (A)	A4TB	27	DO (A)	A6TB	27	21G	8-3.41	(AB)4	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	19NA-2	DO (A)	A4TB	27	DA4 (A)	/	1					
2-3	LVR/AL2	16AWG	19PA-1	DO (A)	A4TB	28	DO (A)	A6TB	28					
2-3	LVR/AL2	16AWG	19PA-2	DO (A)	P6	3	DO (A)	A4TB	28					
2-3	LVR/AL2	16AWG	19PA-3	DO (A)	A6TB	28	DO (A)	P6-1	1					
2-3	LVR/AL2	16AWG	19RA-1	DO (A)	A4TB	21	DO (A)	A6TB	21					
2-3	LVR/AL2	16AWG	19RA-2	DO (A)	A6TB	21	SD6 (A)	/	2					
2-3	LVR/AL2	16AWG	19SA-1	DO (A)	A4TB	22	DO (A)	A6TB	22					
2-3	LVR/AL2	16AWG	19SA-2	DO (A)	A6TB	22	SA4 (A)	TB	4					
2-3	LVR/AL2	16AWG	19TA-1	DO (A)	A4TB	29	DO (A)	P6-2	1					
2-3	LVR/AL2	16AWG	19TA-2	DO (A)	P6	1	DO (A)	A4TB	29					
2-3	LVR/AL2	16AWG/TH06	35CA-3	CL1 (A)	TB	2	CL2 (A)	TB	2	31A	11-3.35	A5	INTERIOR SPEAKERS	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG/TH08	35CA-5	CL2 (A)	TB	2	CL3 (A)	TB	2					
2-3	LVR/AL2	16AWG/TH10	35CA-7	CL3 (A)	TB	2	CL4 (A)	TB	2	31A	11-3.35	A4		
2-3	LVR/AL2	16AWG/TH06	35DA-3	CL1 (A)	TB	1	CL2 (A)	TB	1	31A	11-3.35	A5		
2-3	LVR/AL2	16AWG/TH08	35DA-5	CL2 (A)	TB	1	CL3 (A)	TB	1					
2-3	LVR/AL2	16AWG/TH10	35DA-7	CL3 (A)	TB	1	CL4 (A)	TB	1	31A	11-3.35	A4		
2-3	LVR/AL2	16AWG	46MA-5	NB4 (A)	/	3	NB3 (A)	/	1	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	14AWG	48AA-3	DO (A)	A2TB	32	LE3 (A)	TB	3	26D	8-3.59	B8	DOOR OPERATOR	SEE SH. 26B (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	48AE-4	LE4 (A)	TB	2	LM2 (A)	/	1	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-3	LVR/AL2	16AWG	48AE-5	LE3 (A)	TB	4	LM4 (A)	L1	1					
2-3	LVR/AL2	16AWG	48AE-6	LM4 (A)	L1	1	LM4 (A)	L2	1					
2-3	LVR/AL2	16AWG	48AJ-1	LE4 (A)	/	B	LE1 (A)	/	B					
2-3	LVR/AL2	16AWG	48AK-1	LE4 (A)	/	B	LE1 (A)	/	B					
2-3	LVR/AL2	16AWG	48AL-1	LE4 (A)	/	Y	LE1 (A)	/	Y					
2-3	LVR/AL2	16AWG	48AM-1	LE4 (A)	/	Y	LE1 (A)	/	Y					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 8 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL2	16AWG	61AA-4	DP (A)	A2TB	12	DP (A)	A4TB	12	32A	8-3.71	C6	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	12AWG	61BA-2	DP (A)	A2TB	8	KR (A)	TB2	2					
2-3	LVR/AL2	12AWG	61BB-1	DP (A)	A2TB	9	DP (A)	A4TB	8					
2-3	LVR/AL2	12AWG	66BC-1	DP (A)	A1TB	8	DP (A)	A4TB	9					
2-3	LVR/AL2	12AWG	ET007-3	SA2 (A)	TB	6	SA4 (A)	TB	6	22C	8-3.51	C6	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	12AWG	ET008-3	SA2 (A)	TB	5	SA4 (A)	TB	5					
2-3	LVR/AL2	16AWG	NB36-16	DO (A)	P2	2	DA2 (A)	/	2	21G	8-3.41	(AB)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	NB36-20	DO (A)	P2-2	2	LX2 (A)	/	2					
2-3	LVR/AL2	16AWG	NB36-21	DO (A)	A4TB	14	DO (A)	A6TB	14	21G	8-3.41	(AB)4		
2-3	LVR/AL2	16AWG	NB36-22	DO (A)	A4TB	23	DO (A)	A6TB	23					
2-3	LVR/AL2	16AWG	NB36-23	DO (A)	A4TB	15	DO (A)	A6TB	15					
2-3	LVR/AL2	16AWG	NB36-24	DO (A)	A6TB	31	DR6 (A)	/	4					
2-3	LVR/AL2	16AWG	NB36-26	DO (A)	P6	2	DO (A)	A6TB	20					
2-3	LVR/AL2	16AWG	NB36-29	DO (A)	A6TB	23	DO (A)	P6-2	2					
2-3	LVR/AL2	16AWG	NB36-3	DO (A)	A4TB	31	DA4 (A)	/	2					
2-3	LVR/AL2	16AWG	NB36-30	DO (A)	A6TB	20	DO (A)	P6-1	2					
2-3	LVR/AL2	16AWG	NB36-33	DO (A)	A4TB	19	DO (A)	A6TB	19					
2-3	LVR/AL2	16AWG	NB36-34	DO (A)	A4TB	20	DO (A)	A6TB	20					
2-3	LVR/AL2	16AWG	NB36-35	DO (A)	A2TB	31	LX2 (A)	/	2					
2-3	LVR/AL2	16AWG	NB36-36	DO (A)	A4TB	31	LX4 (A)	/	2					
2-3	LVR/AL2	16AWG	NB36-40	DO (A)	A2TB	23	SD2 (A)	/	2	21G	8-3.41	(AB)7	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	NB36-41	DO (A)	A6TB	23	SD6 (A)	/	1	21G	8-3.41	(AB)4		
2-3	LVR/AL2	16AWG	NB36-55	DO (A)	A4TB	26	DO (A)	A6TB	26					
2-3	LVR/AL2	16AWG	NB36-6	DO (A)	A2TB	23	DA2 (A)	/	2	21G	8-3.41	(AB)7		
2-3	LVR/AL2	14AWG	NB54-2	LE4 (A)	TB	1	LE3 (A)	TB	1	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	NB54-5	LE4 (A)	TB	1	LM2 (A)	/	2					
2-3	LVR/AL2	16AWG	NB54-7	LE3 (A)	TB	2	LM4 (A)	L1	2					
2-3	LVR/AL2	16AWG	NB54-8	LM4 (A)	L1	2	LM4 (A)	L2	2					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION LH SIDE	REV. 00 Page 9 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-3	LVR/AL2	16AWG	S36-5	DO (A)	A4TB	10	DO (A)	A6TB	10	21G	8-3.41	(AB)4	DOOR OPERATOR	SEE SH. 21C (PAGE 8-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	16AWG	S36-5	DO (A)	A6TB	10	DO (A)	A4TB	10					
2-3	LVR/AL2	16AWG	S40-9	DO (A)	A2TB	4	KR (A)	TB4	8	21F	8-3.39	C6	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	2X16AWG	TH-06	CL1 (A)	TB	3	CL2 (A)	TB	3	31A	11-3.35	A5	INTERIOR SPEAKERS	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-3	LVR/AL2	2X16AWG	TH-08	CL2 (A)	TB	3	CL3 (A)	TB	3					
2-3	LVR/AL2	2X16AWG	TH-10	CL3 (A)	TB	3	CL4 (A)	TB	3	31A	11-3.35	A4		
2-3	LVR/AL2	16AWG	X16-10	NB4 (A)	/	4	NB3 (A)	/	2	43A	8-3.75	B5	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)



Location Illustration Code: 2-4

Figure 11-1.19 Raceway Location - "B" Body Section - RH Side

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION RH SIDE		REV. 00 — Page 1 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	CRT/01-04	16AWG	18JA-8	DM3 (B)	/	7	DK3 (B)	/	25	21H	8-3.43	C6	EXTERNAL DOOR CREW SWITCH	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/01-04	16AWG	18JB-2	DM3 (B)	/	17	DK3 (B)	/	17					
2-4	CRT/01-04	16AWG	18JB-3	DM3 (B)	/	17	DO (B)	B3TB	15					
2-4	CRT/01-04	16AWG	18JC-1	DM3 (B)	/	12	DK3 (B)	/	12					
2-4	CRT/01-04	16AWG	18JD-2	DM3 (B)	/	24	DK3 (B)	/	24					
2-4	CRT/01-04	16AWG	18JD-3	DM3 (B)	/	24	DO (B)	B3TB	14					
2-4	CRT/01-04	16AWG	18JE-1	DM3 (B)	/	21	DK3 (B)	/	21					
2-4	CRT/01-04	16AWG	NB37-17	DM3 (B)	/	22	DR3 (B)	/	4					
2-4	CRT/01-08	16AWG	17NA-3	DR5 (B)	/	2	DF5 (B)	/	2	21H	8-3.43	D4	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/01-08	16AWG	17NB-3	DR5 (B)	/	1	DF5 (B)	/	1					
2-4	CRT/01-08	16AWG	17NB-4	DR5 (B)	/	3	DR5 (B)	/	1					
2-4	CRT/01-08	16AWG	NB37-5	DR5 (B)	/	4	DA5 (B)	/	2					
2-4	CRT/01-10	16AWG	17NA-5	DR7 (B)	/	2	DF7 (B)	/	2	21H	8-3.43	C2	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/01-10	16AWG	17NB-6	DR7 (B)	/	1	DF7 (B)	/	1					
2-4	CRT/01-10	16AWG	17NB-7	DR7 (B)	/	1	DR7 (B)	/	3					
2-4	CRT/01-10	16AWG	NB37-27	DR7 (B)	/	4	DO (B)	B7TP	31					
2-4	CRT/02-01	16AWG	18JA-6	DK3 (B)	/	16	DO (B)	B3TB	13	21H	8-3.43	D6	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-01	16AWG	18JA-8	DK3 (B)	/	25	DM3 (B)	/	7					
2-4	CRT/02-01	16AWG	18JB-2	DK3 (B)	/	17	DM3 (B)	/	17					
2-4	CRT/02-01	16AWG	18JC-1	DK3 (B)	/	12	DM3 (B)	/	12					
2-4	CRT/02-01	16AWG	18JD-2	DK3 (B)	/	24	DM3 (B)	/	24					
2-4	CRT/02-01	16AWG	18JE-1	DK3 (B)	/	21	DM3 (B)	/	21					
2-4	CRT/02-01	16AWG	36QA-4	CI (B)	TB	2	EYJ (B)	J10	1	31A	11-3.35	G2	INTERCOMM. UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-01	16AWG	36RA-4	CI (B)	TB	1	EYJ (B)	J10	2					
2-4	CRT/02-01	16AWG	48BE-8	LM1 (B)	L1	1	LM1 (B)	L2	1	26D	10-3.29	A5	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-01	16AWG/TH27	ET084-1	CI (B)	TB	4	KH (B)	TB3	3	31A	11-3.35	G2	INTERCOMM. UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-01	16AWG/TH27	ET085-1	CI (B)	TB	3	KH (B)	TB3	4					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00 Page 2 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	CRT/02-01	16AWG	NB55-16	LM1 (B)	L1	2	LM1 (B)	L2	2	26D	10-3.29	A5	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-01	2X16AWG	TH-27	CI (B)	TB	5	KH (B)	TB3	5	31A	11-3.35	G2	INTERCOMM. UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-02	16AWG	18MA-4	DF3 (B)	/	2	DO (B)	B3TB	25	21H	8-3.43	D6	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-02	16AWG	18MB-5	DF3 (B)	/	1	DO (B)	B3TB	24					
2-4	CRT/02-02	16AWG/TH47	35AA-4	CH (B)	/	2	EYJ (B)	J10	48	31A	11-3.35	A3	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-02	16AWG	NB37-16	DR3 (B)	/	4	DO (B)	B3TB	31	21H	8-3.43	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-02	16AWG	NB37-17	DR3 (B)	/	4	DM3 (B)	/	22					
2-4	CRT/02-02	2X16AWG	TH-47	CH (B)	/	/	EYJ (B)	J10	46	31A	11-3.35	A3	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-03	16AWG	18MA-5	DR3 (B)	/	2	DF3 (B)	/	2	21H	8-3.43	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-03	16AWG	18MB-6	DR3 (B)	/	1	DF3 (B)	/	1					
2-4	CRT/02-03	16AWG	18MB-7	DR3 (B)	/	1	DR3 (B)	/	3					
2-4	CRT/02-03	16AWG/TH47	35AA-4	CH (B)	/	2	EYJ (B)	J10	48	31A	11-3.35	A3	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-03	16AWG/TH47	35BA-4	CH (B)	/	1	EYJ (B)	J10	47					
2-4	CRT/02-03	16AWG	NB37-16	DR3 (B)	/	4	DO (B)	B3TB	31	21H	8-3.43	D6	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-03	16AWG	NB37-17	DR3 (B)	/	4	DM3 (B)	/	22					
2-4	CRT/02-03	2X16AWG	TH-47	CH (B)	/	/	EYJ (B)	J10	46	31A	11-3.35	A3	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	17NA-2	DF5 (B)	/	2	DO (B)	B5TB	25	21H	8-3.43	D4	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	17NB-2	DF5 (B)	/	1	LX5 (B)	/	1					
2-4	CRT/02-06	16AWG	46MA-4	NB2 (B)	/	1	KQ (B)	TB6	6	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	46MA-6	NB2 (B)	/	3	NB1 (B)	/	1					
2-4	CRT/02-06	16AWG	48BE-6	LM5 (B)	L1	1	LM5 (B)	L2	1	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	CRT/02-06	16AWG	NB37-5	DR5 (B)	/	4	DA5 (B)	/	2	21H	8-3.43	D4	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	NB55-12	LM5 (B)	L1	2	LM5 (B)	L2	2	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	X16-11	NB2 (B)	/	4	NB1 (B)	/	2	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-06	16AWG	X16-7	NB2 (B)	/	2	KQ (B)	TB6	7					
2-4	CRT/02-07	16AWG	14BA-4	SA5 (B)	TB	16	SC5 (B)	TB	2	22D	8-3.51	A4	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-07	16AWG	14BB-1	SA5 (B)	TB	15	SC5 (B)	TB	1					
2-4	CRT/02-07	16AWG	14BC-3	SA5 (B)	TB	7	SC5 (B)	TB	6					
2-4	CRT/02-07	16AWG	14CA-4	SA5 (B)	TB	14	SC5 (B)	TB	4					
2-4	CRT/02-07	16AWG	17QA-2	SA5 (B)	TB	4	DO (B)	B7TB	22	21H	8-3.43	D2	STEP MOVING EQUIPMENT	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-07	12AWG	ET005-3	SA5 (B)	TB	5	SA1 (B)	TB	5	22C	8-3.49	C4	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-07	12AWG	ET005-4	SA5 (B)	TB	5	EYJ (B)	J7	26					
2-4	CRT/02-07	12AWG	ET006-3	SA5 (B)	TB	6	SA1 (B)	TB	6					
2-4	CRT/02-07	12AWG	ET006-4	SA5 (B)	TB	6	EYJ (B)	J7	25					
2-4	CRT/02-09	16AWG	17NA-4	DF7 (B)	/	2	DO (B)	B7TB	25	21H	8-3.43	C2	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-09	16AWG	17NB-5	DF7 (B)	/	1	DO (B)	B7TB	24					
2-4	CRT/02-09	16AWG	46MA-6	NB1 (B)	/	1	NB2 (B)	/	3	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-09	16AWG	48BE-5	LM5 (B)	L1	1	LE2 (B)	TB	4	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-09	16AWG	48BE-6	LM5 (B)	L1	1	LM5 (B)	L2	1					
2-4	CRT/02-09	16AWG	NB37-27	DR7 (B)	/	4	DO (B)	B7TP	31	21H	8-3.43	C2	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-09	16AWG	NB55-11	LM5 (B)	L1	2	LE2 (B)	TB	2	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/02-09	16AWG	NB55-12	LM5 (B)	L1	2	LM5 (B)	L2	2					
2-4	CRT/02-09	16AWG	X16-11	NB1 (B)	/	2	NB2 (B)	/	4	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION RH SIDE		REV. 00 Page 4 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	CRT/03-05	16AWG	61BB-2	DN (B)	/	1	DN (B)	TB	1	32A	8-3.71	C4	PASSENGER EMERGENCY STOP	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	CRT/03-05	16AWG	61BC-1	DN (B)	/	2	DN (B)	TB	3					
2-4	CRT/03-05	16AWG	ET063-4	DN (B)	/	3	DN (B)	TB	2					
2-4	CRT/03-05	16AWG	ET063-6	DN (B)	/	3	DN (B)	/	+					
2-4	CRT/03-05	16AWG	ET069-15	DN (B)	/	4	KQ (B)	TLP1	/					
2-4	IVR/BR	14AWG	47CA-3	LA2 (B)	TB	2	EYJ (B)	J3	C	26C	10-3.27	A4	CEILING LIGHT CIRCUIT “AC CIRCUIT”	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	IVR/BR	16AWG	47CA-4	LA2 (B)	/	B	LA2 (B)	TB	2					
2-4	IVR/BR	16AWG	47CA-5	LA2 (B)	TB	2	LA1 (B)	/	B					
2-4	IVR/BR	6AWG	70AE-3	HC (B)	V2	C	EYJ (B)	J4	E	40	9-3.19	C2	HVAC LOADS	
2-4	IVR/BR	12AWG	70AG-2	HQ (B)	TB1	2	EYJ (B)	J3	G	40	9-3.19	D4	CAB HEATER	
2-4	IVR/BR	6AWG	71AE-3	HC (B)	V2	B	EYJ (B)	J3	E	40	9-3.19	C2	HVAC LOADS	
2-4	IVR/BR	10AWG	72AC-3	KO (B)	1	1	KO (B)	2	1	40	5-3.151	D2	CONVENIENCE OUTLETS	
2-4	IVR/BR	6AWG	72AE-3	HC (B)	V2	A	EYJ (B)	J3	D	40	9-3.19	C2	HVAC LOADS	
2-4	IVR/BR	12AWG	72AG-2	HQ (B)	TB1	1	EYJ (B)	J3	H	40	9-3.19	D4	CAB HEATER	
2-4	IVR/BR	14AWG	73AA-12	HC (B)	V2	D	EYJ (B)	J4	C	40	9-3.19	C2	HVAC LOADS	
2-4	IVR/BR	14AWG	73AA-29	LA2 (B)	TB	1	LA4 (B)	TB	1	26C	10-3.27	A4	CEILING LIGHT CIRCUIT “AC CIRCUIT”	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	IVR/BR	16AWG	73AA-31	LA2 (B)	TB	1	LA1 (B)	/	W					
2-4	IVR/BR	16AWG	73AA-32	LA2 (B)	/	W	LA2 (B)	TB	1	26C	10-3.27	A4		
2-4	IVR/BR	10AWG	73AA-36	KO (B)	1	2	KO (B)	2	2	40	5-3.151	D2	CONVENIENCE OUTLETS	
2-4	LVR/BR1	16AWG	17EA-5	DO (B)	B5TB	7	DO (B)	B7TB	7	21F	8-3.39	C4	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	17MD-1	DO (B)	B5TB	5	DO (B)	B7TB	4					
2-4	LVR/BR1	16AWG	17NA-1	DO (B)	B5TB	25	DO (B)	B7TB	25	21H	8-3.43	(CD)3	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	17NA-2	DO (B)	B5TB	25	DF5 (B)	/	2					
2-4	LVR/BR1	16AWG	17NA-4	DO (B)	B7TB	25	DF7 (B)	/	2					
2-4	LVR/BR1	16AWG	17NB-1	DO (B)	B5TB	24	DO (B)	B7TB	24					
2-4	LVR/BR1	16AWG	17NB-5	DO (B)	B7TB	24	DF7 (B)	/	1					
2-4	LVR/BR1	16AWG	17NB-8	DO (B)	B5TB	24	LX5 (B)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00 — Page 5 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR1	16AWG	17PA-1	DO (B)	B5TB	27	DO (B)	B7TB	27	21H	8-3.43	(CD)3	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	17PA-2	DO (B)	B5TB	27	DA5 (B)	/	1					
2-4	LVR/BR1	16AWG	17QA-1	DO (B)	B5TB	22	DO (B)	B7TB	22					
2-4	LVR/BR1	16AWG	17QA-2	DO (B)	B7TB	22	SA5 (B)	TB	4					
2-4	LVR/BR1	16AWG	17RA-1	DO (B)	B5TB	21	DO (B)	B7TB	21					
2-4	LVR/BR1	16AWG	17RA-2	DO (B)	B7TB	21	SD7 (B)	/	1					
2-4	LVR/BR1	16AWG	17TA-1	DO (B)	B5TB	17	DO (B)	B7TB	17					
2-4	LVR/BR1	16AWG	17UA-1	DO (B)	B5TB	28	DO (B)	B7TB	28					
2-4	LVR/BR1	16AWG	17UA-2	DO (B)	P7	3	DO (B)	B5TB	28					
2-4	LVR/BR1	16AWG	17UA-3	DO (B)	B7TB	28	DO (B)	P7-1	1					
2-4	LVR/BR1	16AWG	17VA-1	DO (B)	B7TB	29	DO (B)	P7-2	1					
2-4	LVR/BR1	16AWG	17VA-2	DO (B)	P7	1	DO (B)	B7TB	29					
2-4	LVR/BR1	16AWG	17WA-1	DO (B)	B5TB	18	DO (B)	B7TB	18					
2-4	LVR/BR1	12AWG	18AA-2	DO (B)	B5TB	1	DO (B)	B7TB	1	21E	8-3.37	A5	DOOR OPERATOR	SEE SH. 21A (PAGE 8-3.29FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	12AWG	18AA-5	DO (B)	B1TB	1	KR (B)	TB3	7	21E	8-3.37	A4		
2-4	LVR/BR1	12AWG	18BA-2	DO (B)	B5TB	2	DO (B)	B7TB	2	21E	8-3.37	A5		
2-4	LVR/BR1	12AWG	18BA-5	DO (B)	B1TB	2	KR (B)	TB3	8	21E	8-3.37	A4		
2-4	LVR/BR1	12AWG	18CA-2	DO (B)	B5TB	3	DO (B)	B7TB	3	21E	8-3.37	A5		
2-4	LVR/BR1	12AWG	18CA-5	DO (B)	B1TB	3	KR (B)	TB3	9	21E	8-3.37	A4		
2-4	LVR/BR1	16AWG	18MA-2	DO (B)	B1TB	25	DF1 (B)	/	2	21H	8-3.43	(CD)7	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	18MB-2	DO (B)	B1TB	24	DF1 (B)	/	1					
2-4	LVR/BR1	16AWG	18MB-8	DO (B)	B1TB	24	LX1 (B)	/	1					
2-4	LVR/BR1	16AWG	18TA-1	DO (B)	B1TB	27	DO (B)	B3TB	27					
2-4	LVR/BR1	16AWG	18TA-2	DO (B)	B1TB	27	DA1 (B)	/	1					
2-4	LVR/BR1	16AWG	18UA-1	DO (B)	B1TB	28	DO (B)	B3TB	28					
2-4	LVR/BR1	16AWG	18UA-2	DO (B)	P3	3	DO (B)	B1TB	28					
2-4	LVR/BR1	16AWG	19XA-1	DO (B)	B1TB	40	DV1 (B)	/	1					
2-4	LVR/BR1	16AWG	19ZA-1	DO (B)	B3TB	40	DV3 (B)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00 Page 6 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR1	16AWG	44BA-2	FV (B)	TB2	8	KR (B)	TB1	17	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	46MA-6	NB1 (B)	/	1	NB2 (B)	/	3	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	48BA-20	DO (B)	B1TB	32	DO (B)	B3TB	32	26D	8-3.59	A5	DOOR OPERATOR	SEE SH. 26B (PAGE 8-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	10AWG	48BA-3	LE2 (B)	TB	3	EYJ (B)	J5	35	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-4	LVR/BR1	14AWG	48BA-5	LE2 (B)	TB	3	LE3 (B)	TB	3					
2-4	LVR/BR1	14AWG	48BA-8	DO (B)	B3TB	32	LE2 (B)	TB	3	26D	8-3.59	B5	DOOR OPERATOR	
2-4	LVR/BR1	16AWG	48BB-20	DO (B)	B3TB	33	LE1 (B)	TB	2					
2-4	LVR/BR1	16AWG	48BB-6	DO (B)	B1TB	33	LE1 (B)	TB	2	26D	8-3.59	A5	DOOR OPERATOR	
2-4	LVR/BR1	16AWG	48BE-3	LE2 (B)	TB	4	EYJ (B)	J11	BT	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-4	LVR/BR1	16AWG	48BE-5	LE2 (B)	TB	4	LM5 (B)	L1	1					
2-4	LVR/BR1	16AWG	48BE-6	LM5 (B)	L1	1	LM5 (B)	L2	1					
2-4	LVR/BR1	16AWG	48BE-7	LE2 (B)	TB	4	LM1 (B)	L1	1					
2-4	LVR/BR1	16AWG	48BE-8	LM1 (B)	L1	1	LM1 (B)	L2	1	26D	10-3.29	A5	STEPWELL LIGHT	
2-4	LVR/BR1	16AWG/TH59	49AA-3	KX (B)	TB1	1	KG (B)	TB1	1	35	12-3.33	B(3-4)	SIDE DESTINATION SIGN	
2-4	LVR/BR1	16AWG/TH59	49BA-3	KX (B)	TB1	2	KG (B)	TB1	2					
2-4	LVR/BR1	16AWG	51AB-1	KX (B)	/	Y	LC (B)	/	Y	26C	12-3.27	B2	SIDE DESTINATION SIGN	SEE SH. 26A (PAGE 12-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	51AC-1	KX (B)	/	Y	LC (B)	/	Y					
2-4	LVR/BR1	16AWG	51AD-1	KX (B)	/	B	LC (B)	/	B					
2-4	LVR/BR1	16AWG	51AE-1	KX (B)	/	B	LC (B)	/	B					
2-4	LVR/BR1	16AWG	51AG-1	KY (B)	/	R	LC (B)	/	R					
2-4	LVR/BR1	16AWG	51AH-1	KY (B)	/	R	LC (B)	/	R					
2-4	LVR/BR1	16AWG	51AJ-1	KY (B)	/	Y	LC (B)	/	Y					
2-4	LVR/BR1	16AWG	51AK-1	KY (B)	/	Y	LC (B)	/	Y					
2-4	LVR/BR1	16AWG	61AA-5	DP (B)	B1TB	12	DP (B)	B5TB	12	32A	8-3.71	C4	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	12AWG	61BA-2	DP (B)	B1TB	8	KR (B)	TB2	13					
2-4	LVR/BR1	12AWG	61BB-1	DN (B)	TB	1	DP (B)	B1TB	9					
2-4	LVR/BR1	12AWG	61BC-2	DN (B)	TB	3	DP (B)	B5TB	8					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00 — Page 7 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR1	12AWG	66BD-1	DP (B)	B2TB	8	DP (B)	B5TB	9	32A	8-3.71	C4	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	12AWG	ET005-3	SA1 (B)	TB	5	SA5 (B)	TB	5	22C	8-3.49	C3	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	12AWG	ET005-4	SA5 (B)	TB	5	EYJ (B)	J7	26	22C	8-3.49	C4		
2-4	LVR/BR1	12AWG	ET006-3	SA1 (B)	TB	6	SA5 (B)	TB	6	22C	8-3.49	C3		
2-4	LVR/BR1	12AWG	ET006-4	SA5 (B)	TB	6	EYJ (B)	J7	25	22C	8-3.49	C4		
2-4	LVR/BR1	16AWG/TH27	ET084-1	CI (B)	TB	4	KH (B)	TB3	3	31A	11-3.35	G2	INTERCOMM. UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG/TH27	ET085-1	CI (B)	TB	3	KH (B)	TB3	4					
2-4	LVR/BR1	16AWG	NB27-3	KX (B)	TB1	4	KG (B)	TB1	4	35	12-3.33	B(3-4)	SIDE DESTINATION SIGN	
2-4	LVR/BR1	16AWG	NB37-23	DO (B)	B7TB	23	DO (B)	P7-2	2	21H	8-3.43	(CD)3	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	NB37-24	DO (B)	B7TB	20	DO (B)	P7-1	2					
2-4	LVR/BR1	16AWG	NB37-27	DO (B)	B7TP	31	DR7 (B)	/	4					
2-4	LVR/BR1	16AWG	NB37-3	DO (B)	B5TB	31	DA5 (B)	/	2					
2-4	LVR/BR1	16AWG	NB37-32	DO (B)	B5TB	20	DO (B)	B7TB	20					
2-4	LVR/BR1	16AWG	NB37-33	DO (B)	B5TB	19	DO (B)	B7TB	19					
2-4	LVR/BR1	16AWG	NB37-34	DO (B)	B5TB	15	DO (B)	B7TB	15					
2-4	LVR/BR1	16AWG	NB37-35	DO (B)	B5TB	14	DO (B)	B7TB	14					
2-4	LVR/BR1	16AWG	NB37-38	DO (B)	P7	2	DO (B)	B7TB	20					
2-4	LVR/BR1	16AWG	NB37-40	DO (B)	B1TB	31	LX1 (B)	/	2					
2-4	LVR/BR1	16AWG	NB37-41	DO (B)	B5TB	31	LX5 (B)	/	2					
2-4	LVR/BR1	16AWG	NB37-51	DO (B)	B7TB	23	SD7 (B)	/	2					
2-4	LVR/BR1	16AWG	NB37-53	DO (B)	B1TB	26	DO (B)	B3TB	26					
2-4	LVR/BR1	16AWG	NB37-55	DO (B)	B5TB	26	DO (B)	B7TB	26					
2-4	LVR/BR1	16AWG	NB37-9	DO (B)	B5TB	23	DO (B)	B7TB	23					
2-4	LVR/BR1	16AWG	NB55-11	LE2 (B)	TB	2	LM5 (B)	L1	2	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION RH SIDE		REV. 00 Page 8 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR1	16AWG	NB55-12	LM5 (B)	L1	2	LM5 (B)	L2	2	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	14AWG	NB55-13	LE1 (B)	TB	1	LE2 (B)	TB	2÷1	26D	10-3.29	A5	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-4	LVR/BR1	16AWG	NB55-15	LE1 (B)	TB	1	LM1 (B)	L1	2					
2-4	LVR/BR1	16AWG	NB55-16	LM1 (B)	L1	2	LM1 (B)	L2	2	26D	10-3.29	A5	STEPWELL LIGHT	
2-4	LVR/BR1	10AWG	NB55-2	LE2 (B)	TB	1	EYJ (B)	J5	36	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-4	LVR/BR1	16AWG	NB55-9	LE2 (B)	TB	1	LE3 (B)	TB	2÷1					
2-4	LVR/BR1	16AWG	S37-5	DO (B)	B5TB	10	DO (B)	B7TB	10	21H	8-3.43	(CD)3	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	S37-5	DO (B)	B7TB	10	DO (B)	B5TB	10					
2-4	LVR/BR1	2X16AWG	TH-27	CI (B)	TB	5	KH (B)	TB3	5	31A	11-3.35	G2	INTERCOMM. UNIT PASSENGER AREA	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	2X16AWG	TH-59	KX (B)	TB1	5	KG (B)	TB1	6	35	12-3.33	B(3-4)	SIDE DESTINATION SIGN	
2-4	LVR/BR1	16AWG	X16-11	NB1 (B)	/	2	NB2 (B)	/	4	43A	8-3.75	B3	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR1	16AWG	X27-5	KX (B)	TB1	3	KG (B)	TB1	3	35	12-3.33	B(3-4)	SIDE DESTINATION SIGN	
2-4	LVR/BR1	16AWG	X29-5	FV (B)	TB2	18	KR (B)	TB1	7÷8	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	14BA-1	SC1 (B)	TB	1	SA1 (B)	TB	15	22D	8-3.51	A4	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG	14BA-2	SC5 (B)	TB	2	SC1 (B)	TB	1	22D	8-3.51	A5		
2-4	LVR/BR2	16AWG	14BA-4	SC5 (B)	TB	2	SA5 (B)	TB	16					
2-4	LVR/BR2	16AWG	14BB-1	SC5 (B)	TB	1	SA5 (B)	TB	15					
2-4	LVR/BR2	16AWG	14BC-1	SC1 (B)	TB	6	SA1 (B)	TB	7	22D	8-3.51	A4		
2-4	LVR/BR2	16AWG	14BC-2	SC5 (B)	TB	6	SC1 (B)	TB	6	22D	8-3.51	A5		
2-4	LVR/BR2	16AWG	14BC-3	SC5 (B)	TB	6	SA5 (B)	TB	7					
2-4	LVR/BR2	16AWG	14CA-1	SC1 (B)	TB	3	SA1 (B)	TB	13	22D	8-3.51	A4		
2-4	LVR/BR2	12AWG	14CA-2	SC5 (B)	TB	4	SC1 (B)	TB	3	22D	8-3.51	A5		
2-4	LVR/BR2	16AWG	14CA-4	SC5 (B)	TB	4	SA5 (B)	TB	14					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION RH SIDE		REV. 00 — Page 9 of 11

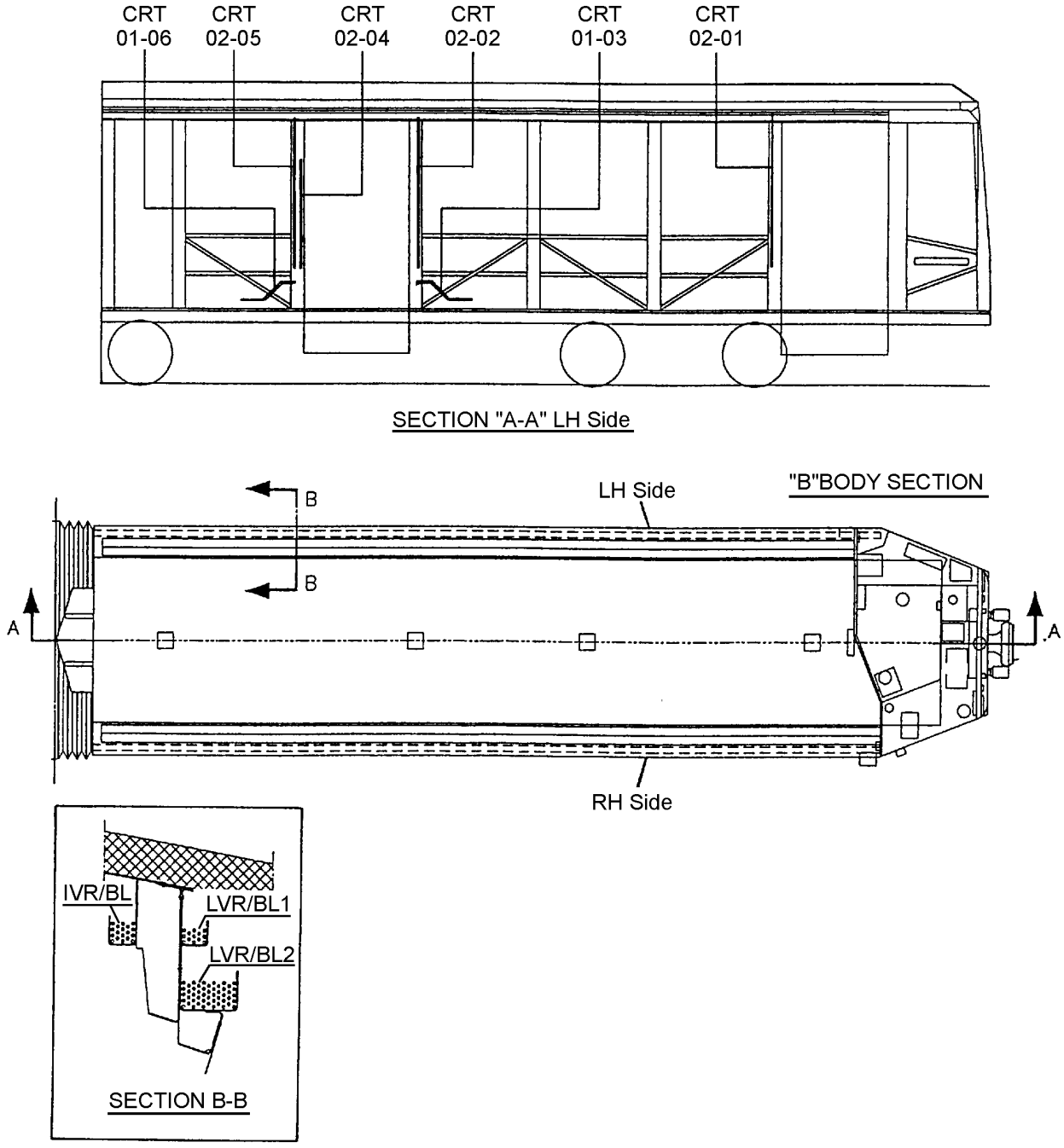
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR2	16AWG	14CB-1	SC5 (B)	TB	3	SA5 (B)	TB	13	22D	8-3.51	A5	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	18KA-2	DO (B)	B1TB	20	AC (B)	A2-P2	T	21H	8-3.43	(CD)7	DOOR OPERATOR	
2-4	LVR/BR2	16AWG	18NA-1	SC1 (B)	TB	10	DO (B)	B3TB	30	21H	8-3.43	D6	CUT OUT SWITCH PANEL	
2-4	LVR/BR2	16AWG	18NB-2	SC1 (B)	TB	11	SA1 (B)	TB	1					
2-4	LVR/BR2	16AWG	46MA-4	KQ (B)	TB6	6	NB2 (B)	/	1	43A	5-3.167	C4	RSR - STOP REQUEST COMMAND RELAY	SEE SH. 43 (PAGE 5-3.165 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	48BB-5	KQ (B)	TB7	8	LE1 (B)	TB	2	26D	5-3.113	C3	RCC - INTERIOR LIGHT CONTROL RELAY	SEE SH. 26B (PAGE 5-3.109 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	51AA-2	KQ (B)	TB3	12	LC (B)	/	+	26C	5-3.111	C2	RID - INTERIOR LIGHTING COMMAND RELAY	SEE SH. 26A (PAGE 5-3.107 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	55QC-1	KB (B)	TB2	15	FV (B)	TB2	4	46A	5-3.177	B1	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	56AD-16	KB (B)	TB2	21	FV (B)	TB2	15	47A	5-3.181	C2	TERMINAL BOARD PANEL	SEE SH. 47 (PAGE 5-3.179 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	61AA-3	KQ (B)	TB7	11	DP (B)	B1TB	12	32A	5-3.141	A4	RPES - PASSENGER EMERGENCY STOP RELAY	SEE SH. 32 (PAGE 5-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG/TH53	80JA-2	KB (B)	TB3	15	FN (B)	EPA1	b6	16	5-3.73	C1	TERMINAL BOARD PANEL	
2-4	LVR/BR2	12AWG	ET010	SC1 (B)	TB	4	KH (B)	TB6	23	22D	8-3.51	A4	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	ET010-3	SC1 (B)	TB	4	SA1 (B)	TB	14					
2-4	LVR/BR2	12AWG	ET011	SC1 (B)	TB	2	KH (B)	TB6	20					
2-4	LVR/BR2	16AWG	ET011-3	SC1 (B)	TB	2	SA1 (B)	TB	16					
2-4	LVR/BR2	16AWG	ET048-10	KQ (B)	TLN2	/	DN (B)	/	-	32A	5-3.141	B5	AUXILIARY RELAY PANEL 1	SEE SH. 32 (PAGE 5-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	ET049-10	KQ (B)	TLN1	/	FV (B)	TB1	1	46A	5-3.177	C1	AUXILIARY RELAY PANEL 1	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION RH SIDE	REV. 00 Page 10 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR2	12AWG/TH53	ET051-3	KB (B)	TB3	14	FN (B)	EPA1	c6	16	5-3.73	C1	TERMINAL BOARD PANEL	
2-4	LVR/BR2	12AWG/TH52	ET053-4	KQ (B)	TB9	15	FV (B)	TB2	13	29A	5-3.129	A5	REMA - EMERGENCY RELAY	SEE SH. 29 (PAGE 5-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG/TH52	ET054-4	KQ (B)	TB9	14	FV (B)	TB2	14					
2-4	LVR/BR2	16AWG	ET057-3	KB (B)	TB3	12	FV (B)	TB2	16	16	5-3.73	B1	TERMINAL BOARD PANEL	
2-4	LVR/BR2	16AWG	ET058-3	KB (B)	TB3	11	FV (B)	TB2	17					
2-4	LVR/BR2	16AWG	ET063-3	KB (B)	TB5	4	DN (B)	TB	4	32A	5-3.141	B4	TERMINAL BOARD PANEL	SEE SH. 32 (PAGE 5-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	ET069-15	KQ (B)	TLP1	/	DN (B)	/	4	32A	5-3.141	A4	AUXILIARY RELAY PANEL 1	
2-4	LVR/BR2	10AWG	NB37	KB (B)	TB8	4	SC1 (B)	TB	13	12D	5-3.65	B(1-4)	TERMINAL BOARD PANEL	SEE SH. 12B (PAGE 5-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG	NB37-1	SC1 (B)	TB	9	DO (B)	B5TB	23	21H	8-3.43	D6	CUT OUT SWITCH PANEL	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	16AWG	NB37-15	SC1 (B)	TB	9	SA1 (B)	TB	2					
2-4	LVR/BR2	12AWG	NB37-2	SC1 (B)	TB	9	DO (B)	B1TB	23					
2-4	LVR/BR2	16AWG	NB37-21	SC1 (B)	TB	13	DO (B)	P3-1	2					
2-4	LVR/BR2	16AWG	NB37-6	DO (B)	B1TB	31	KB (B)	TB4	4					
2-4	LVR/BR2	16AWG	NB99-3	KQ (B)	TB10	22	LZ (B)	L1	1	50B	5-3.189	B6	RCE - CAB CONTROL RELAY	
2-4	LVR/BR2	10AWG	S37-2	KB (B)	TB9	2	SC1 (B)	TB	8	12D	5-3.65	B(1-4)	TERMINAL BOARD PANEL	SEE SH. 12B (PAGE 5-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG	S37-3	SC1 (B)	TB	8	DO (B)	B5TB	10	21H	8-3.43	D6	CUT OUT SWITCH PANEL	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	12AWG	S37-4	SC1 (B)	TB	8	DO (B)	B1TB	10					
2-4	LVR/BR2	16AWG	SPARE36	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE38	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE39	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE40	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE56	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE57	KB (B)	/	/	FV (B)	/	/	/	/	/	/	
2-4	LVR/BR2	16AWG	SPARE58	KB (B)	/	/	FV (B)	/	/	/	/	/	/	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION RH SIDE		REV. 00 — Page 11 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-4	LVR/BR2	2X12AWG	TH-52	KQ (B)	TB9	13	FV (B)	/	/	29A	5-3.127	A5	AUXILIARY RELAY PANEL 1	SEE SH. 29 (PAGE 5-3.127 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-4	LVR/BR2	2X12AWG	TH-53	KB (B)	TB3	17	FN (B)	/	/	16	5-3.73	C1	TERMINAL BOARD PANEL	
2-4	LVR/BR2	16AWG	X16-7	KQ (B)	TB6	7	NB2 (B)	/	2	43A	5-3.167	C4	RSR - STOP REQUEST COMMAND RELAY	SEE SH. 43 (PAGE 5-3.165 FOR VEHICLES # 1400, 1401, 1403, 1449)



Location Illustration Code: 2-5

Figure 11-1.20 Raceway Location - "B" Body Section - LH Side

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 1 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	CRT/01-03	16AWG	19KA-3	DR4 (B)	/	2	DF4 (B)	/	2	21H	8-3.43	B5	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/01-03	16AWG	19KB-3	DR4 (B)	/	1	DF4 (B)	/	1					
2-5	CRT/01-03	16AWG	19KB-4	DR4 (B)	/	1	DR4 (B)	/	3					
2-5	CRT/01-03	16AWG	NB36-4	DR4 (B)	/	4	DA4 (B)	/	2					
2-5	CRT/01-06	16AWG	19KA-5	DR6 (B)	/	2	DF6 (B)	/	2	21H	8-3.43	A3		
2-5	CRT/01-06	16AWG	19KB-6	DR6 (B)	/	1	DF6 (B)	/	1					
2-5	CRT/01-06	16AWG	19KB-7	DR6 (B)	/	1	DR6 (B)	/	3					
2-5	CRT/01-06	16AWG	NB36-24	DR6 (B)	/	4	DO (B)	B6TB	31					
2-5	CRT/02-01	16AWG	19AA-5	DK2 (B)	/	16	DO (B)	B2TB	13	21H	8-3.43	B6	INTERNAL DOOR CREW SWITCH	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-01	16AWG	19AA-7	DK2 (B)	/	25	DM2 (B)	/	25					
2-5	CRT/02-01	16AWG	19DA-1	DF2 (B)	/	2	DO (B)	B2TB	25	21H	8-3.43	A7	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-01	16AWG	19DA-2	DF2 (B)	/	2	DR2 (B)	/	2					
2-5	CRT/02-01	16AWG	19DB-1	DF2 (B)	/	1	DO (B)	B2TB	24					
2-5	CRT/02-01	16AWG	19DB-2	DF2 (B)	/	1	DR2 (B)	/	1					
2-5	CRT/02-01	16AWG	19JB-2	DK2 (B)	/	17	DM2 (B)	/	17	21H	8-3.43	B6	INTERNAL DOOR CREW SWITCH	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-01	16AWG	19JC-1	DK2 (B)	/	12	DM2 (B)	/	12					
2-5	CRT/02-01	16AWG	19JD-2	DK2 (B)	/	24	DM2 (B)	/	24					
2-5	CRT/02-01	16AWG	19JE-1	DK2 (B)	/	21	DM2 (B)	/	21					
2-5	CRT/02-01	16AWG	48BD-5	LM2 (B)	/	1	LE4 (B)	TB	2	26D	10-3.25	A3	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.27 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-01	16AWG	NB55-5	LM2 (B)	/	2	LE4 (B)	TB	1					
2-5	CRT/02-02	16AWG	19KA-2	DF4 (B)	/	2	DO (B)	B4TB	25	21H	8-3.43	B5	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	19KA-3	DF4 (B)	/	2	DR4 (B)	/	2					
2-5	CRT/02-02	16AWG	19KB-2	DF4 (B)	/	1	LX4 (B)	/	1					
2-5	CRT/02-02	16AWG	19KB-3	DF4 (B)	/	1	DR4 (B)	/	1					
2-5	CRT/02-02	16AWG	19KB-4	DR4 (B)	/	1	DR4 (B)	/	3					
2-5	CRT/02-02	16AWG	46MA-3	NB4 (B)	/	1	KQ (B)	TB6	6	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	46MA-5	NB4 (B)	/	3	NB3 (B)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 2 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	CRT/02-02	16AWG	48BD-7	LM4 (B)	L1	1	LE3 (B)	TB	4	26D	10-3.25	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.27 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	48BD-8	LM4 (B)	L1	1	LM4 (B)	L2	1					
2-5	CRT/02-02	16AWG	NB36-4	DR4 (B)	/	4	DA4 (B)	/	2	21H	8-3.43	B5	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	NB55-7	LM4 (B)	L1	2	LE3 (B)	TB	2	26D	10-3.25	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.27 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	NB55-8	LM4 (B)	L1	2	LM4 (B)	L2	2					
2-5	CRT/02-02	16AWG	X16-10	NB4 (B)	/	2	NB3 (B)	/	2	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-02	16AWG	X16-6	NB4 (B)	/	2	KQ (B)	TB6	7					
2-5	CRT/02-04	16AWG	14BE-4	SA4 (B)	TB	16	SC4 (B)	TB	2	22D	8-3.51	C4	STEP MOVING EQUIPMENT	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-04	16AWG	14BF-4	SA4 (B)	TB	14	SC4 (B)	TB	4					
2-5	CRT/02-04	16AWG	14BG-1	SA4 (B)	TB	13	SC4 (B)	TB	3					
2-5	CRT/02-04	16AWG	14BH-1	SA4 (B)	TB	15	SC4 (B)	TB	1					
2-5	CRT/02-04	16AWG	14DB-3	SA4 (B)	TB	7	SC4 (B)	TB	6					
2-5	CRT/02-04	16AWG	19SA-2	SA4 (B)	TB	4	DO (B)	B6TB	22	21H	8-3.43	B3	STEP MOVING EQUIPMENT	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-04	12AWG	ET007-1	SA4 (B)	TB	6	SA2 (B)	TB	6	22C	8-3.49	D4	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-04	12AWG	ET007-2	SA4 (B)	TB	6	EYJ (B)	J7	23					
2-5	CRT/02-04	12AWG	ET008-1	SA4 (B)	TB	5	SA2 (B)	TB	5					
2-5	CRT/02-04	12AWG	ET008-2	SA4 (B)	TB	5	EYJ (B)	J7	24	22C	8-3.49	D4	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	19KA-4	DF6 (B)	/	2	DO (B)	B6TB	25	21H	8-3.43	B4	INTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	19KA-5	DF6 (B)	/	2	DR6 (B)	/	2					
2-5	CRT/02-05	16AWG	19KB-5	DF6 (B)	/	1	DO (B)	B6TB	24					
2-5	CRT/02-05	16AWG	19KB-6	DF6 (B)	/	1	DR6 (B)	/	1					
2-5	CRT/02-05	16AWG	19KB-7	DR6 (B)	/	1	DR6 (B)	/	3	21H	8-3.43	A3	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 3 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	CRT/02-05	16AWG	46MA-5	NB3 (B)	/	1	NB4 (B)	/	3	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	48BD-7	LM4 (B)	L1	1	LE3 (B)	TB	4	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	48BD-8	LM4 (B)	L1	1	LM4 (B)	L2	1					
2-5	CRT/02-05	16AWG	NB36-24	DR6 (B)	/	4	DO (B)	B6TB	31	21H	8-3.43	A3	EXTERNAL PASSENGER PUSHBUTTON	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	NB55-7	LM4 (B)	L1	2	LE3 (B)	TB	2	26D	10-3.29	A4	STEPWELL LIGHT	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	CRT/02-05	16AWG	NB55-8	LM4 (B)	L1	2	LM4 (B)	L2	2					
2-5	CRT/02-05	16AWG	X16-10	NB3 (B)	/	2	NB4 (B)	/	2	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	IVR/BL	16AWG	47BA-10	LA4 (B)	/	B	LA4 (B)	TB	2	26C	10-3.27	A3	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	IVR/BL	16AWG	47BA-10	LA4 (B)	TB	2	LA4 (B)	/	B					
2-5	IVR/BL	16AWG	47BA-11	LA4 (B)	TB	2	LA3 (B)	/	B					
2-5	IVR/BL	14AWG	47BA-4	LA4 (B)	TB	2	EYJ (B)	J3	A					
2-5	IVR/BL	14AWG	73AA-10	LA4 (B)	TB	1	EYJ (B)	J4	B					
2-5	IVR/BL	16AWG	73AA-25	LA4 (B)	TB	1	LA3 (B)	/	W					
2-5	IVR/BL	16AWG	73AA-26	LA4 (B)	/	W	LA4 (B)	TB	1					
2-5	IVR/BL	16AWG	73AA-26	LA4 (B)	TB	1	LA4 (B)	/	W					
2-5	IVR/BL	14AWG	73AA-29	LA4 (B)	TB	1	LA2 (B)	TB	1					
2-5	LVR/BL1	16AWG	17EA-10	DO (B)	B2TB	7	DO (B)	B4TB	7	21F	8-3.39	D3	DOOR OPERATOR	SEE SH. 21B (PAGE 8-3.31 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	17EA-10	DO (B)	B4TB	7	DO (B)	B2TB	7					
2-5	LVR/BL1	16AWG	17EA-9	DO (B)	B4TB	7	DO (B)	B6TB	7					
2-5	LVR/BL1	16AWG	17LA-3	DO (B)	B2TB	4	EYJ (B)	J11	AB					
2-5	LVR/BL1	16AWG	17LB-1	DO (B)	B2TB	5	DO (B)	B4TB	4					
2-5	LVR/BL1	16AWG	17LC-1	DO (B)	B4TB	5	DO (B)	B6TB	4					
2-5	LVR/BL1	16AWG	17YA-1	DO (B)	B2TB	22	SA2 (B)	TB	4	21H	8-3.43	(AB)7	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	17ZA-1	DO (B)	B2TB	27	DA2 (B)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 4 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL1	12AWG	18DA-3	DO (B)	B4TB	1	DO (B)	B6TB	1	21E	8-3.37	D3	DOOR OPERATOR	SEE SH. 21A (PAGE 8-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	12AWG	18DA-4	DO (B)	B2TB	1	DO (B)	B4TB	1					
2-5	LVR/BL1	12AWG	18DA-5	DO (B)	B2TB	1	KR (B)	TB3	4					
2-5	LVR/BL1	12AWG	18EA-3	DO (B)	B4TB	2	DO (B)	B6TB	2					
2-5	LVR/BL1	12AWG	18EA-4	DO (B)	B2TB	2	DO (B)	B4TB	2					
2-5	LVR/BL1	12AWG	18EA-5	DO (B)	B2TB	2	KR (B)	TB3	5					
2-5	LVR/BL1	12AWG	18FA-3	DO (B)	B4TB	3	DO (B)	B6TB	3					
2-5	LVR/BL1	12AWG	18FA-4	DO (B)	B2TB	3	DO (B)	B4TB	3					
2-5	LVR/BL1	12AWG	18FA-5	DO (B)	B2TB	3	KR (B)	TB3	6					
2-5	LVR/BL1	16AWG	19AA-5	DO (B)	B2TB	13	DK2 (B)	/	16	21H	8-3.43	(AB)7	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	19AA-7	DM2 (B)	/	25	DK2 (B)	/	25	21H	8-3.43	B6	EXTERNAL DOOR CREW SWITCH	
2-5	LVR/BL1	16AWG	19DA-1	DO (B)	B2TB	25	DF2 (B)	/	2	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	19DA-2	DR2 (B)	/	2	DF2 (B)	/	2	21H	8-3.43	A7	EXTERNAL PASSENGER PUSHBUTTON	
2-5	LVR/BL1	16AWG	19DB-1	DO (B)	B2TB	24	DF2 (B)	/	1	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	19DB-2	DR2 (B)	/	1	DF2 (B)	/	1	21H	8-3.43	A7	EXTERNAL PASSENGER PUSHBUTTON	
2-5	LVR/BL1	16AWG	19DB-4	DO (B)	B2TB	24	LX2 (B)	/	1	21H	8-3.43	(AB)7	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	19EA-1	DO (B)	P2	3	DO (B)	B2TB	28					
2-5	LVR/BL1	16AWG	19EA-2	DO (B)	B2TB	28	DO (B)	P2-1	1					
2-5	LVR/BL1	16AWG	19EA-2	DO (B)	P2-1	1	DO (B)	B2TB	28					
2-5	LVR/BL1	16AWG	19FA-1	DO (B)	B2TB	21	SD2 (B)	/	1					
2-5	LVR/BL1	16AWG	19GA-1	DO (B)	P2	1	DO (B)	B2TB	18					
2-5	LVR/BL1	16AWG	19GA-3	DO (B)	B2TB	18	DO (B)	P2-2	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 5 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL1	16AWG	19JB-2	DM2 (B)	/	17	DK2 (B)	/	17	21H	8-3.43	B6	EXTERNAL DOOR CREW SWITCH	
2-5	LVR/BL1	16AWG	19JB-3	DO (B)	B2TB	15	DM2 (B)	/	17	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	19JC-1	DM2 (B)	/	12	DK2 (B)	/	12	21H	8-3.43	B6	EXTERNAL DOOR CREW SWITCH	
2-5	LVR/BL1	16AWG	19JD-2	DM2 (B)	/	24	DK2 (B)	/	24					
2-5	LVR/BL1	16AWG	19JD-3	DO (B)	B2TB	14	DM2 (B)	/	24	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	19JE-1	DM2 (B)	/	21	DK2 (B)	/	21	21H	8-3.43	B6	EXTERNAL DOOR CREW SWITCH	
2-5	LVR/BL1	16AWG	19KA-1	DO (B)	B4TB	25	DO (B)	B6TB	25	21H	8-3.43	(AB)4	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	19KA-2	DO (B)	B4TB	25	DF4 (B)	/	2					
2-5	LVR/BL1	16AWG	19KA-4	DO (B)	B6TB	25	DF6 (B)	/	2					
2-5	LVR/BL1	16AWG	19KB-1	DO (B)	B4TB	24	DO (B)	B6TB	24					
2-5	LVR/BL1	16AWG	19KB-2	LX4 (B)	/	1	DF4 (B)	/	1	21H	8-3.43	A5	PUSH BAR LAMP	
2-5	LVR/BL1	16AWG	19KB-5	DO (B)	B6TB	24	DF6 (B)	/	1	21H	8-3.43	(AB)4	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	19KB-8	DO (B)	B4TB	24	LX4 (B)	/	1					
2-5	LVR/BL1	16AWG	19LA-1	DO (B)	B4TB	18	DO (B)	B6TB	18					
2-5	LVR/BL1	16AWG	19MA-1	DO (B)	B4TB	17	DO (B)	B6TB	17					
2-5	LVR/BL1	16AWG	19NA-1	DO (B)	B4TB	27	DO (B)	B6TB	27					
2-5	LVR/BL1	16AWG	19NA-2	DO (B)	B4TB	27	DA4 (B)	/	1					
2-5	LVR/BL1	16AWG	19PA-1	DO (B)	B4TB	28	DO (B)	B6TB	28					
2-5	LVR/BL1	16AWG	19PA-2	DO (B)	P6	3	DO (B)	B4TB	28					
2-5	LVR/BL1	16AWG	19PA-3	DO (B)	B6TB	28	DO (B)	P6-1	1					
2-5	LVR/BL1	16AWG	19RA-1	DO (B)	B4TB	21	DO (B)	B6TB	21					
2-5	LVR/BL1	16AWG	19RA-2	DO (B)	B6TB	21	SD6 (B)	/	2					
2-5	LVR/BL1	16AWG	19SA-1	DO (B)	B4TB	22	DO (B)	B6TB	22					
2-5	LVR/BL1	16AWG	19SA-2	DO (B)	B6TB	22	SA4 (B)	TB	4					
2-5	LVR/BL1	16AWG	19TA-1	DO (B)	B4TB	29	DO (B)	P6-2	1					
2-5	LVR/BL1	16AWG	19TA-2	DO (B)	P6	1	DO (B)	B4TB	29					
2-5	LVR/BL1	16AWG/TH41	35CA-12	CL3 (B)	TB	2	CL4 (B)	TB	2	31A	11-3.35	A3	INTERIOR SPEAKER	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 6 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL1	16AWG/TH43	35CA-14	CL2 (B)	TB	2	CL3 (B)	TB	2	31A	11-3.35	A2	INTERIOR SPEAKER	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG/TH45	35CA-16	CL1 (B)	/	2	CL2 (B)	TB	2					
2-5	LVR/BL1	16AWG/TH41	35DA-12	CL3 (B)	TB	1	CL4 (B)	TB	1	31A	11-3.35	A3		
2-5	LVR/BL1	16AWG/TH43	35DA-14	CL2 (B)	TB	1	CL3 (B)	TB	1	31A	11-3.35	A2		
2-5	LVR/BL1	16AWG/TH45	35DA-16	CL1 (B)	/	1	CL2 (B)	TB	1					
2-5	LVR/BL1	16AWG	44BB-39	FV (B)	TB3	4	KT (B)	TB2	21	46A	5-3.177	B3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	46MA-5	NB4 (B)	/	3	NB3 (B)	/	1	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	14AWG	48BA-6	DO (B)	B2TB	32	LE3 (B)	TB	3	26D	8-3.59	B3	DOOR OPERATOR	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	48BD-5	LE4 (B)	TB	2	LM2 (B)	/	1	26D	10-3.29	A3	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-5	LVR/BL1	16AWG	48BD-6	LE4 (B)	TB	2	LE3 (B)	TB	4					
2-5	LVR/BL1	16AWG	48BD-7	LE3 (B)	TB	4	LM4 (B)	L1	1					
2-5	LVR/BL1	16AWG	48BD-8	LM4 (B)	L1	1	LM4 (B)	L2	1	26D	10-3.29	A4	STEPWELL LIGHT	
2-5	LVR/BL1	16AWG	48BJ-1	LE4 (B)	/	B	LE1 (B)	/	B	26D	10-3.29	A3	CEILING LIGHT CIRCUIT "EMERGENCY"	
2-5	LVR/BL1	16AWG	48BK-1	LE4 (B)	/	B	LE1 (B)	/	B					
2-5	LVR/BL1	16AWG	48BL-1	LE4 (B)	/	Y	LE1 (B)	/	Y					
2-5	LVR/BL1	16AWG	48BM-1	LE4 (B)	/	Y	LE1 (B)	/	Y					
2-5	LVR/BL1	16AWG	54BA-2	KF (B)	TB1	1	KT (B)	TB2	16	46A	16-3.27	B4	FRICT. BRAKE FAULT ANNUNC. RELAIES PANEL	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	54CA-2	KF (B)	TB1	2	KT (B)	TB2	15					
2-5	LVR/BL1	16AWG	54DA-2	KF (B)	TB1	3	KT (B)	TB2	14					
2-5	LVR/BL1	16AWG	54EA-1	FS1 (B)	B12	1	KT (B)	TB2	12	46A	16-3.27	C5	CUT OUT BRAKE VALVE	
2-5	LVR/BL1	16AWG	61AA-4	DP (B)	B2TB	12	DP (B)	B4TB	12	32A	8-3.71	D4	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	12AWG	66BE-1	DP (B)	B2TB	9	DP (B)	B4TB	8					
2-5	LVR/BL1	12AWG	ET007-1	SA2 (B)	TB	6	SA4 (B)	TB	6	22C	8-3.49	D3	STEP MOVING EQUIPMENT	SEE SH. 22A (PAGE 8-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	12AWG	ET008-1	SA2 (B)	TB	5	SA4 (B)	TB	5					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 7 of 9

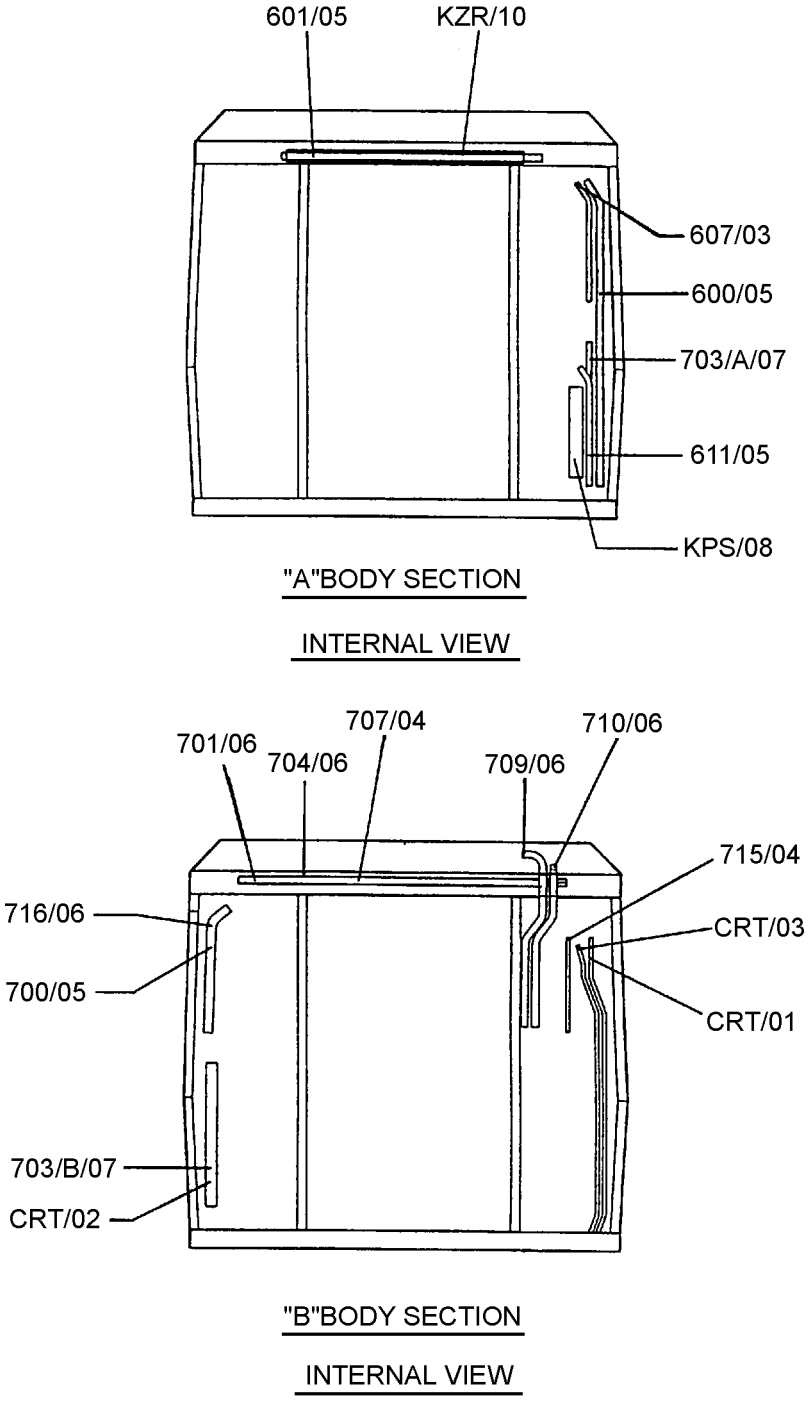
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL1	16AWG	NB29-4	FS1 (B)	B12	2	FS2 (B)	B12	2	46A	16-3.27	C5	CUT OUT BRAKE VALVE	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	NB36-16	DO (B)	P2	2	DA2 (B)	/	2	21H	8-3.43	(AB)7	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	NB36-20	DO (B)	P2-2	2	LX2 (B)	/	2					
2-5	LVR/BL1	16AWG	NB36-21	DO (B)	B4TB	14	DO (B)	B6TB	14	21H	8-3.43	(AB)4	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	NB36-22	DO (B)	B4TB	23	DO (B)	B6TB	23					
2-5	LVR/BL1	16AWG	NB36-23	DO (B)	B4TB	15	DO (B)	B6TB	15					
2-5	LVR/BL1	16AWG	NB36-24	DO (B)	B6TB	31	DR6 (B)	/	4					
2-5	LVR/BL1	16AWG	NB36-26	DO (B)	P6	2	DO (B)	B6TB	20					
2-5	LVR/BL1	16AWG	NB36-29	DO (B)	B6TB	23	DO (B)	P6-2	2					
2-5	LVR/BL1	16AWG	NB36-3	DO (B)	B4TB	31	DA4 (B)	/	2					
2-5	LVR/BL1	16AWG	NB36-30	DO (B)	B6TB	20	DO (B)	P6-1	2					
2-5	LVR/BL1	16AWG	NB36-33	DO (B)	B4TB	19	DO (B)	B6TB	19					
2-5	LVR/BL1	16AWG	NB36-34	DO (B)	B4TB	20	DO (B)	B6TB	20					
2-5	LVR/BL1	16AWG	NB36-35	DO (B)	B2TB	31	LX2 (B)	/	2	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	NB36-36	DO (B)	B4TB	31	LX4 (B)	/	2	21H	8-3.43	(AB)4	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	NB36-4	DA4 (B)	/	2	DR4 (B)	/	4	21H	8-3.43	B5	OBSTRUCTION ALARM	
2-5	LVR/BL1	16AWG	NB36-40	DO (B)	B2TB	23	SD2 (B)	/	2	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	NB36-41	DO (B)	B6TB	23	SD6 (B)	/	1	21H	8-3.43	(AB)4	DOOR OPERATOR	
2-5	LVR/BL1	16AWG	NB36-55	DO (B)	B4TB	26	DO (B)	B6TB	26					
2-5	LVR/BL1	16AWG	NB36-6	DO (B)	B2TB	23	DA2 (B)	/	2	21H	8-3.43	(AB)7	DOOR OPERATOR	
2-5	LVR/BL1	14AWG	NB55-3	LE4 (B)	TB	1	LE3 (B)	TB	1	26D	10-3.29	A3	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.27 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	16AWG	NB55-5	LE4 (B)	TB	1	LM2 (B)	/	2					
2-5	LVR/BL1	16AWG	NB55-7	LE3 (B)	TB	2	LM4 (B)	L1	2					
2-5	LVR/BL1	16AWG	NB55-8	LM4 (B)	L1	2	LM4 (B)	L2	2	26D	10-3.29	A4	STEPWELL LIGHT	
2-5	LVR/BL1	16AWG	S36-5	DO (B)	B4TB	10	DO (B)	B6TB	10	21H	8-3.43	(AB)4	DOOR OPERATOR	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 8 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL1	2X16AWG	TH-41	CL3 (B)	TB	3	CL4 (B)	TB	3	31A	11-3.35	A3	INTERIOR SPEAKER	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	2X16AWG	TH-43	CL2 (B)	TB	3	CL3 (B)	TB	3	31A	11-3.35	A2	INTERIOR SPEAKER	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL1	2X16AWG	TH-45	CL1 (B)	/	/	CL2 (B)	TB	3					
2-5	LVR/BL1	16AWG	X16-10	NB4 (B)	/	2	NB3 (B)	/	2	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	14BE-1	SC2 (B)	TB	1	SA2 (B)	TB	15	22D	8-3.51	D4	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	12AWG	14BE-2	SC4 (B)	TB	2	SC2 (B)	TB	1	22D	8-3.51	D5		
2-5	LVR/BL2	16AWG	14BE-4	SC4 (B)	TB	2	SA4 (B)	TB	16					
2-5	LVR/BL2	16AWG	14BF-1	SC2 (B)	TB	3	SA2 (B)	TB	13	22D	8-3.51	D4		
2-5	LVR/BL2	12AWG	14BF-2	SC4 (B)	TB	4	SC2 (B)	TB	3	22D	8-3.51	D5		
2-5	LVR/BL2	16AWG	14BF-4	SC4 (B)	TB	4	SA4 (B)	TB	14					
2-5	LVR/BL2	16AWG	14BG-1	SC4 (B)	TB	3	SA4 (B)	TB	13					
2-5	LVR/BL2	16AWG	14BH-1	SC4 (B)	TB	1	SA4 (B)	TB	15					
2-5	LVR/BL2	16AWG	14DB-1	SC2 (B)	TB	6	SA2 (B)	TB	7					
2-5	LVR/BL2	16AWG	14DB-2	SC4 (B)	TB	6	SC2 (B)	TB	6					
2-5	LVR/BL2	16AWG	14DB-3	SC4 (B)	TB	6	SA4 (B)	TB	7					
2-5	LVR/BL2	16AWG	17EA-2	KQ (B)	TB4	15	DO (B)	B6TB	7	21F	5-3.85	B3	RTF - TRAIN FUNCTIONING RELAY	SEE SH. 21B (PAGE 5-3.77 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	17EA-3	KQ (B)	TB4	15	DO (B)	B7TB	7					
2-5	LVR/BL2	16AWG	17XA-1	SC2 (B)	TB	10	DO (B)	B2TB	11	21H	8-3.43	B6	CUT OU SWITCH PANEL	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	17XB-2	SC2 (B)	TB	11	SA2 (B)	TB	1					
2-5	LVR/BL2	16AWG	19BA-1	DO (B)	B2TB	20	AC (B)	A2-P2	X	21H	8-3.43	(AB)4	DOOR OPERATOR	
2-5	LVR/BL2	16AWG	19CA-1	DO (B)	B2TB	19	AC (B)	A2-P2	Z					
2-5	LVR/BL2	16AWG	46MA-3	KQ (B)	TB6	6	NB4 (B)	/	1	43A	5-3.167	C4	RSR - STOP REQUEST COMMAND RELAY	SEE SH. 43 (PAGE 5-3.165 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	47DA-3	KQ (B)	TB6	5	LG1 (B)	/	1	43A	5-3.167	C2	AUXILIARY RELAY PANEL 1	
2-5	LVR/BL2	16AWG	47DA-4	KQ (B)	TB6	5	LG2 (B)	/	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "B" BODY SECTION LH SIDE		REV. 00 Page 9 of 9

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	TO	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-5	LVR/BL2	16AWG	48BA-9	KQ (B)	TB7	1	DO (B)	B2TB	32	26D	5-3.113	C3	RCC - INTERIOR LIGHT CONTROL RELAY	SEE SH. 26B (PAGE 5-3.109 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	48BB-2	KQ (B)	TB7	8	DO (B)	B2TB	33					
2-5	LVR/BL2	16AWG	61AA-2	KQ (B)	TB7	11	DP (B)	B2TB	12	32A	5-3.141	A4	RPES - PASSENGER EMERGENCY STOP RELAY	SEE SH. 32 (PAGE 5-3.139 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	12AWG	ET009	SC2 (B)	TB	4	KH (B)	TB6	22	22D	8-3.51	D4	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	ET009-3	SC2 (B)	TB	4	SA2 (B)	TB	14					
2-5	LVR/BL2	12AWG	ET012	SC2 (B)	TB	2	KH (B)	TB6	21					
2-5	LVR/BL2	16AWG	ET012-3	SC2 (B)	TB	2	SA2 (B)	TB	16					
2-5	LVR/BL2	16AWG	NB16-2	KQ (B)	TB6	2	LG1 (B)	/	2	43A	5-3.167	C2	AUXILIARY RELAY PANEL 1	SEE SH. 43 (PAGE 5-3.165 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	NB16-3	KQ (B)	TB6	2	LG2 (B)	/	2					
2-5	LVR/BL2	10AWG	NB36	KB (B)	TB8	4	SC2 (B)	TB	9	12D	5-3.65	B(1-4)	TERMINAL BOARD PANEL	SEE SH. 12B (PAGE 5-3.61FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	12AWG	NB36-1	SC2 (B)	TB	9	DO (B)	B4TB	23	21H	8-3.75	B6	CUT OU SWITCH PANEL	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	16AWG	NB36-17	SC2 (B)	TB	13	DO (B)	P2-1	2					
2-5	LVR/BL2	12AWG	NB36-2	SC2 (B)	TB	9	DO (B)	B2TB	23					
2-5	LVR/BL2	16AWG	NB36-5	SC2 (B)	TB	13	SA2 (B)	TB	2					
2-5	LVR/BL2	16AWG	NB36-8	SC2 (B)	TB	13	DR2 (B)	/	4					
2-5	LVR/BL2	16AWG	NB36-9	DO (B)	B2TB	31	AC (B)	A2-P2	V					
2-5	LVR/BL2	16AWG	NB99-4	KQ (B)	TB10	22	LZ (B)	L2	1	50B	5-3.189	B6	RCE - CAB CONTROL RELAY	
2-5	LVR/BL2	10AWG	S36-2	KB (B)	TB9	1	SC2 (B)	TB	8	12D	5-3.65	D(1-4)	TERMINAL BOARD PANEL	SEE SH. 12B (PAGE 5-3.61FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	12AWG	S36-3	SC2 (B)	TB	8	DO (B)	B4TB	10	21H	8-3.75	B6	CUT OU SWITCH PANEL	SEE SH. 21D (PAGE 8-3.35 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-5	LVR/BL2	12AWG	S36-4	SC2 (B)	TB	8	DO (B)	B2TB	10					
2-5	LVR/BL2	16AWG	X16-6	KQ (B)	TB6	7	NB4 (B)	/	2	43A	8-3.75	B4	PULL CORD SWITCH	SEE SH. 43 (PAGE 8-3.73 FOR VEHICLES # 1400, 1401, 1403, 1449)



Location Illustration Code: 2-6

Figure 11-1.21 Raceway Location - "A" and "B" Body Sections - Art. Sect. Front

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 1 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	600/05	14AWG	47AA-2	LA2 (A)	TB	2	BG (A)	TB1	5	26C	10-3.27	A5	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	600/05	14AWG	47BA-2	LA5 (A)	TB	2	BG (A)	TB1	6÷7	26C	10-3.27	A7		
2-6	600/05	6AWG	70AD-2	HC (A)	V2	C	BG (A)	TB2	3	40	9-3.19	C5	HVAC LOADS	
2-6	600/05	12AWG	70AG-2	HQ (A)	TB1	2	BG (A)	TB1	1	40	9-3.19	D4	CAB HEATER	
2-6	600/05	6AWG	71AD-2	HC (A)	V2	B	BG (A)	TB2	2	40	9-3.19	C5	HVAC LOADS	
2-6	600/05	6AWG	72AD-2	HC (A)	V2	A	BG (A)	TB2	1					
2-6	600/05	12AWG	72AG-2	HQ (A)	TB1	1	BG (A)	TB1	3	40	9-3.19	D4	CAB HEATER	
2-6	600/05	14AWG	73AA-4	LA5 (A)	TB	1	BG (A)	TBN	5	26C	10-3.27	A7	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	600/05	14AWG	73AA-5	HC (A)	V2	D	BG (A)	TBN	6	40	9-3.19	C5	HVAC LOADS	
2-6	601/05	14AWG	47AA-2	LA2 (A)	TB	2	BG (A)	TB1	5	26C	10-3.27	A5	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	601/05	16AWG	47BB-1	LA5 (A)	LAMP2	Y	LA5 (A)	BALLAST	Y	26C	10-3.27	A7	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	601/05	16AWG	47BB-1	LA5 (A)	BALLAST	Y	LA5 (A)	LAMP2	Y					
2-6	601/05	16AWG	47BC-1	LA5 (A)	LAMP2	Y	LA5 (A)	BALLAST	Y					
2-6	601/05	16AWG	47BC-1	LA5 (A)	BALLAST	Y	LA5 (A)	LAMP2	Y					
2-6	601/05	16AWG	47BD-1	LA5 (A)	LAMP2	B	LA5 (A)	BALLAST	B					
2-6	601/05	16AWG	47BD-1	LA5 (A)	BALLAST	B	LA5 (A)	LAMP2	B					
2-6	601/05	16AWG	47BE-1	LA5 (A)	LAMP2	B	LA5 (A)	BALLAST	B					
2-6	601/05	16AWG	47BE-1	LA5 (A)	BALLAST	B	LA5 (A)	LAMP2	B					
2-6	601/05	16AWG	47BG-1	LA5 (A)	LAMP1	R	LA5 (A)	BALLAST	R					
2-6	601/05	16AWG	47BG-1	LA5 (A)	BALLAST	R	LA5 (A)	LAMP1	R					
2-6	601/05	16AWG	47BH-1	LA5 (A)	LAMP1	R	LA5 (A)	BALLAST	R					
2-6	601/05	16AWG	47BH-1	LA5 (A)	BALLAST	R	LA5 (A)	LAMP1	R					
2-6	601/05	16AWG	47BJ-1	LA5 (A)	LAMP1	Y	LA5 (A)	BALLAST	Y					
2-6	601/05	16AWG	47BJ-1	LA5 (A)	BALLAST	Y	LA5 (A)	LAMP1	Y					
2-6	601/05	16AWG	47BK-1	LA5 (A)	LAMP1	Y	LA5 (A)	BALLAST	Y					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 2 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	601/05	16AWG	47BK-1	LA5 (A)	BALLAST	Y	LA5 (A)	LAMP1	Y	26C	10-3.27	A7	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	601/05	6AWG	70AD-2	HC (A)	V2	C	BG (A)	TB2	3	40	9-3.19	C5	HVAC LOADS	
2-6	601/05	12AWG	70AG-2	HQ (A)	TB1	2	BG (A)	TB1	1	40	9-3.19	D4	CAB HEATER	
2-6	601/05	6AWG	71AD-2	HC (A)	V2	B	BG (A)	TB2	2	40	9-3.19	C5	HVAC LOADS	
2-6	601/05	6AWG	72AD-2	HC (A)	V2	A	BG (A)	TB2	1					
2-6	601/05	12AWG	72AG-2	HQ (A)	TB1	1	BG (A)	TB1	3	40	9-3.19	D4	CAB HEATER	
2-6	601/05	14AWG	73AA-19	LA2 (A)	TB	1	LA5 (A)	TB	1	26C	10-3.23	A5	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.43 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	601/05	14AWG	73AA-5	HC (A)	V2	D	BG (A)	TBN	6	40	9-3.19	C5	HVAC LOADS	
2-6	607/03	10AWG	48AA-2	LE3 (A)	TB	3	BG (A)	TB4	2	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	607/03	10AWG	NB54-1	LE3 (A)	TB	1÷2	BG (A)	TBN1	6					
2-6	611/05	14AWG	47BA-3	EYP (A)	P3	A	BG (A)	TB1	7	40	7-3.103	C4	ELECTRICAL T/L CONNECTION	
2-6	611/05	14AWG	47CA-2	EYP (A)	P3	C	BG (A)	TB1	8					
2-6	611/05	6AWG	70AE-2	EYP (A)	P4	E	BG (A)	TB2	6	40	7-3.103	B4		
2-6	611/05	12AWG	70AG-3	EYP (A)	P3	G	BG (A)	TB1	1	40	7-3.103	C4		
2-6	611/05	12AWG	70BA-1	EYP (A)	P4	G	BE (A)	/	/	40	7-3.103	A4		
2-6	611/05	6AWG	71AE-2	EYP (A)	P3	E	BG (A)	TB2	5	40	7-3.103	B4		
2-6	611/05	12AWG	71BA-1	EYP (A)	P4	H	BE (A)	/	/	40	7-3.103	A4		
2-6	611/05	10AWG	72AC-5	EYP (A)	P3	B	BG (A)	TB1	4	40	7-3.103	C4		
2-6	611/05	6AWG	72AE-2	EYP (A)	P3	D	BG (A)	TB2	4	40	7-3.103	B4		
2-6	611/05	12AWG	72AG-3	EYP (A)	P3	H	BG (A)	TB1	3	40	7-3.103	C4		
2-6	611/05	12AWG	72BA-1	EYP (A)	P4	I	BE (A)	/	/	40	7-3.103	A4		
2-6	611/05	14AWG	73AA-11	EYP (A)	P4	C	BG (A)	TBN	9	40	7-3.103	B4		
2-6	611/05	10AWG	73AA-6	EYP (A)	P4	A	BG (A)	TBN	7					
2-6	611/05	14AWG	73AA-9	EYP (A)	P4	B	BG (A)	TBN	8					
2-6	700/05	14AWG	47BA-4	EYJ (B)	J3	A	LA4 (B)	TB	2	40	7-3.103	C4		

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.		REV. 00 Page 3 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	700/05	14AWG	47CA-3	EYJ (B)	J3	C	LA2 (B)	TB	2	40	7-3.103	C4	ELECTRICAL T/L CONNECTION	
2-6	700/05	12AWG	70AG-2	EYJ (B)	J3	G	HQ (B)	TB1	2					
2-6	700/05	12AWG	70BA-2	EYJ (B)	J4	G	MO (B)	/	A	40	7-3.103	A4		
2-6	700/05	6AWG	71AE-3	EYJ (B)	J3	E	HC (B)	V2	B	40	7-3.103	B4		
2-6	700/05	12AWG	71BA-2	EYJ (B)	J4	H	MO (B)	/	B	40	7-3.103	A4		
2-6	700/05	10AWG	72AC-2	EYJ (B)	J3	B	KO (B)	1	1	40	7-3.103	C4		
2-6	700/05	6AWG	72AE-3	EYJ (B)	J3	D	HC (B)	V2	A	40	7-3.103	B4		
2-6	700/05	12AWG	72AG-2	EYJ (B)	J3	H	HQ (B)	TB1	1	40	7-3.103	C4		
2-6	700/05	12AWG	72BA-2	EYJ (B)	J4	I	MO (B)	/	C	40	7-3.103	A4		
2-6	701/06	12AWG	14BB-2	EYJ (B)	J7	32	SC5 (B)	TB	1	22D	7-3.51	B5	ELECTRICAL T/L CONNECTION	SEE SH. 22B (PAGE 7-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG	14BC-4	EYJ (B)	J11	n	SC5 (B)	TB	6	22D	7-3.51	A5		
2-6	701/06	12AWG	14CB-2	EYJ (B)	J7	33	SC5 (B)	TB	3	22D	7-3.51	B5		
2-6	701/06	16AWG	17MA-3	EYJ (B)	J11	AC	DO (B)	B1TB	4	21F	7-3.43	D5	ELECTRICAL T/L CONNECTION	SEE SH. 21B (PAGE 7-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG	17ME-1	EYJ (B)	J11	AE	DO (B)	B7TB	5	21F	7-3.43	C5		
2-6	701/06	12AWG	18AA-1	EYJ (B)	J8	12	DO (B)	B7TB	1	21E	7-3.41	A6	ELECTRICAL T/L CONNECTION	SEE SH. 21A (PAGE 7-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	12AWG	18BA-1	EYJ (B)	J8	13	DO (B)	B7TB	2					
2-6	701/06	12AWG	18CA-1	EYJ (B)	J8	14	DO (B)	B7TB	3					
2-6	701/06	16AWG	34XA-2	KE (B)	1	1	KE (B)	2	1	42C	11-3.39	B(3-4)	MAINTENANCE TELEPHONE JACK	SEE SH. 42B (PAGE 11-3.37 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG	34XA-2	KE (B)	2	1	KE (B)	1	1					
2-6	701/06	16AWG	34XA-3	KE (B)	2	1	KE (B)	3	1					
2-6	701/06	16AWG	34XA-3	KE (B)	3	1	KE (B)	2	1					
2-6	701/06	16AWG	34ZA-2	KE (B)	1	2	KE (B)	2	2					
2-6	701/06	16AWG	34ZA-2	KE (B)	2	2	KE (B)	1	2					
2-6	701/06	16AWG/TH47	35AA-4	EYJ (B)	J10	48	CH (B)	/	2	31A	7-3.89	A4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG/TH47	35BA-4	EYJ (B)	J10	47	CH (B)	/	1					
2-6	701/06	16AWG	36QA-4	EYJ (B)	J10	1	CI (B)	TB	2	31A	7-3.89	G4		
2-6	701/06	16AWG	36RA-4	EYJ (B)	J10	2	CI (B)	TB	1					
2-6	701/06	16AWG	44BC-39	EYJ (B)	J11	BF	FV (B)	TB4	5	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 4 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	701/06	14AWG	48BA-5	LE2 (B)	TB	3	LE3 (B)	TB	3	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	701/06	16AWG	48BE-3	EYJ (B)	J11	BT	LE2 (B)	TB	4	26D	7-3.67	C6	ELECTRICAL T/L CONNECTION	
2-6	701/06	16AWG/TH61	49AA-5	EYJ (B)	J11	D	KX (B)	TB1	11	35	7-3.95	C4	ELECTRICAL T/L CONNECTION	
2-6	701/06	16AWG/TH61	49BA-5	EYJ (B)	J11	C	KX (B)	TB1	12					
2-6	701/06	16AWG	54BA-1	EYJ (B)	J11	BH	KF (B)	TB1	1	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG	54CA-1	EYJ (B)	J11	AY	KF (B)	TB1	2					
2-6	701/06	16AWG	54DA-1	EYJ (B)	J11	AX	KF (B)	TB1	3					
2-6	701/06	16AWG	55KA-6	EYJ (B)	J12	h	FV (B)	TB2	21					
2-6	701/06	16AWG	61AA-5	DP (B)	B1TB	12	DP (B)	B5TB	12	32A	8-3.71	C4	PASSENGER EMERGENCY STOP RELEASE	SEE SH. 32 (PAGE 8-3.69 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	16AWG	61AA-5	DP (B)	B5TB	12	DP (B)	B1TB	12	32A	8-3.71	C5		
2-6	701/06	12AWG	66BD-1	DP (B)	B2TB	8	DP (B)	B5TB	9	32A	8-3.71	D4		
2-6	701/06	12AWG	66BD-1	DP (B)	B5TB	9	DP (B)	B2TB	8	32A	8-3.71	C5		
2-6	701/06	16AWG	66BF-1	DP (B)	B4TB	9	EYJ (B)	J11	AS	32A	8-3.71	D4		
2-6	701/06	12AWG	ET005-4	EYJ (B)	J7	26	SA5 (B)	TB	5	22C	7-3.69	C5	ELECTRICAL T/L CONNECTION	SEE SH. 22A (PAGE 7-3.71 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	12AWG	ET005-4	SA5 (B)	TB	5	EYJ (B)	J7	26	22C	8-3.49	C4	STEP MOVING EQUIPMENT	
2-6	701/06	12AWG	ET006-4	EYJ (B)	J7	25	SA5 (B)	TB	6	22C	7-3.69	C5	ELECTRICAL T/L CONNECTION	
2-6	701/06	12AWG	ET006-4	SA5 (B)	TB	6	EYJ (B)	J7	25	22C	8-3.49	C4	STEP MOVING EQUIPMENT	
2-6	701/06	12AWG	ET007-2	EYJ (B)	J7	23	SA4 (B)	TB	6	22C	7-3.69	D5	ELECTRICAL T/L CONNECTION	
2-6	701/06	16AWG	NB27-5	EYJ (B)	J11	A	KX (B)	TB1	4	35	7-3.95	D4	ELECTRICAL T/L CONNECTION	
2-6	701/06	16AWG	NB29-3	FS1 (B)	B12	2	FV (B)	TB1	3	46A	16-3.27	C5	CUT OUT BRAKE VALVE	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 5 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	701/06	16AWG	NB55-9	LE2 (B)	TB	1	LE3 (B)	TB	2÷1	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	701/06	16AWG	SPARE46	EYJ (B)	J12	g	FV (B)	/	/	/	/	/	/	
2-6	701/06	16AWG	SPARE48	EYJ (B)	J12	i	FV (B)	/	/	/	/	/	/	
2-6	701/06	16AWG	SPARE49	EYJ (B)	J12	j	FV (B)	/	/	/	/	/	/	
2-6	701/06	16AWG	SPARE50	EYJ (B)	J12	k	FV (B)	/	/	/	/	/	/	
2-6	701/06	2X16AWG	TH-47	EYJ (B)	J10	46	CH (B)	/	/	31A	7-3.89	A4	ELECTRICAL T/L CONNECTION	SEE SH. 31 (PAGE 7-3.87 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	701/06	2X16AWG	TH-61	EYJ (B)	J11	E	KX (B)	TB1	13	35	7-3.95	C4	ELECTRICAL T/L CONNECTION	
2-6	701/06	16AWG	X27-7	EYJ (B)	J11	B	KX (B)	TB1	3	35	7-3.95	C4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	NB58-4	EYJ (B)	J2	C	MT-B (B)	PTB	D	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	PB58-1	EYJ (B)	J2	B	MT-B (B)	PTB	A	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	703/A/07	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 6 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	703/B/07	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	703/B/07	16AWG	54KA-2	FN (B)	EPA2	b1	FB (B)	/	10	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	703/B/07	16AWG	54LA-2	FN (B)	EPA2	a3	FB (B)	/	12					
2-6	703/B/07	16AWG	54MA-2	FN (B)	EPA2	a1	FB (B)	/	11					
2-6	703/B/07	16AWG	54NA-2	FN (B)	EPA2	b2	FB (B)	/	8					
2-6	703/B/07	16AWG	54PA-2	FN (B)	EPA2	a2	FB (B)	/	5					
2-6	703/B/07	16AWG	54UA-2	FN (B)	EPA2	b3	FB (B)	/	16					
2-6	703/B/07	16AWG	54XA-8	EYJ (B)	J5	33	FG (B)	/	D	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG	55KA-3	EYJ (B)	J5	32	FG (B)	/	F					
2-6	703/B/07	16AWG	55QB-1	FV (B)	TB2	3	PSB (B)	/	D	46A	5-3.87	A3	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	55QD-1	FV (B)	TB1	23	PSB (B)	/	C	46A	5-3.87	B5	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	55RB-1	FV (B)	TB2	6	PSC (B)	/	D	46A	5-3.87	A3	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	55RC-1	FV (B)	TB2	7	FG (B)	/	L					
2-6	703/B/07	16AWG	55RD-1	FV (B)	TB1	18	PSC (B)	/	C	46A	5-3.87	B5	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	703/B/07	16AWG	81JA-4	EYJ (B)	J5	42	FX (B)	/	F	44A	7-3.121	A5	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG	81KA-4	EYJ (B)	J5	43	FX (B)	/	D					
2-6	703/B/07	16AWG/TH51	81LA-1	FN (B)	COM	23	MP (B)	M3	P	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	703/B/07	16AWG/TH51	81MA-1	FN (B)	COM	11	MP (B)	M3	Q					
2-6	703/B/07	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	703/B/07	16AWG	81XA-1	EYJ (B)	J5	37	MP (B)	M3	m	38C	7-3.101	A6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 7 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	703/B/07	16AWG	83AA-1	MD (B)	DP	A	MP (B)	M2	g	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-6	703/B/07	16AWG	83BA-1	MD (B)	DP	B	MP (B)	M2	h					
2-6	703/B/07	16AWG	83CA-1	MD (B)	DP	C	MP (B)	M2	j					
2-6	703/B/07	16AWG	83DA-1	MD (B)	DP	D	MP (B)	M2	K					
2-6	703/B/07	16AWG	83EA-1	MD (B)	DP	E	MP (B)	M2	m					
2-6	703/B/07	16AWG	83FA-1	MD (B)	DP	F	MP (B)	M2	n					
2-6	703/B/07	16AWG	83GA-1	MD (B)	DP	G	MP (B)	M2	p					
2-6	703/B/07	16AWG	83HA-1	MD (B)	DP	H	MP (B)	M2	q					
2-6	703/B/07	16AWG	83JA-1	MD (B)	DP	J	MP (B)	M2	r					
2-6	703/B/07	16AWG	83KA-1	MD (B)	DP	K	MP (B)	M2	s					
2-6	703/B/07	16AWG	83LA-1	MD (B)	DP	L	MP (B)	M2	t					
2-6	703/B/07	16AWG	83MA-1	MD (B)	DP	M	MP (B)	M2	u					
2-6	703/B/07	16AWG	83NA-1	MD (B)	DP	N	MP (B)	M2	v					
2-6	703/B/07	16AWG	83PA-1	MD (B)	DP	P	MP (B)	M2	w					
2-6	703/B/07	16AWG	83QA-1	MD (B)	DP	Q	MP (B)	M2	x					
2-6	703/B/07	16AWG	83RA-1	MD (B)	DP	R	MP (B)	M2	y					
2-6	703/B/07	16AWG	83SA-1	MD (B)	DP	S	MP (B)	M2	z					
2-6	703/B/07	16A/83TH1	83TA-1	MD (B)	DP	W	MP (B)	M2	Q					
2-6	703/B/07	3X16AWG	83TH-1	MD (B)	DP	Z	MP (B)	M2	X					
2-6	703/B/07	16A/83TH1	83UA-1	MD (B)	DP	X	MP (B)	M2	R					
2-6	703/B/07	16A/83TH1	83VA-1	MD (B)	DP	Y	MP (B)	M2	V					
2-6	703/B/07	16AWG	83WA-1	EYJ (B)	J5	50	MP (B)	M2	a	38A	7-3.97	A7	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG	83WB-2	EYJ (B)	J5	49	MP (B)	M2	B					
2-6	703/B/07	18A/84TH9	84QA-1	EYJ (B)	J5	60	MP (B)	M2	C	38A	7-3.97	B7		
2-6	703/B/07	18A/84TH9	84RA-1	EYJ (B)	J5	59	MP (B)	M2	F					
2-6	703/B/07	18A/84TH9	84SA-1	EYJ (B)	J5	58	MP (B)	M2	D					
2-6	703/B/07	18A/84TH9	84TA-1	EYJ (B)	J5	57	MP (B)	M2	E					
2-6	703/B/07	4X18AWG	84TH-12	EYJ (B)	J5	51	MP (B)	M2	N	38A	7-3.97	A7		
2-6	703/B/07	4X18AWG	84TH-9	EYJ (B)	J5	56	MP (B)	M2	G	38A	7-3.97	B7		

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 8 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	703/B/07	18A/84TH12	84UA-1	EYJ (B)	J5	55	MP (B)	M2	H	38A	7-3.97	B7	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	18A/84TH12	84VA-1	EYJ (B)	J5	54	MP (B)	M2	M					
2-6	703/B/07	18A/84TH12	84WA-1	EYJ (B)	J5	53	MP (B)	M2	K	38A	7-3.97	A7		
2-6	703/B/07	18A/84TH12	84XA-1	EYJ (B)	J5	52	MP (B)	M2	L					
2-6	703/B/07	16AWG	NB23-5	EYJ (B)	J5	44	FX (B)	/	B	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	703/B/07	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	703/B/07	2X16AWG	TH-51	FN (B)	/	/	MP (B)	M3	R	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	
2-6	703/B/07	16AWG	X29-11	EYJ (B)	J5	31	FG (B)	/	H	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG	X29-12	FV (B)	TB2	19	PSB (B)	/	A	46A	5-3.177	A3	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	X29-31	FV (B)	TB1	17	PSC (B)	/	A	46A	5-3.177	B5	TERMINAL BOARD PANEL	
2-6	703/B/07	16AWG	X29-41	EYJ (B)	J5	30	FG (B)	/	J	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	
2-6	703/B/07	16AWG	X29-8	FV (B)	TB2	18	FG (B)	/	N	46A	5-3.177	A3	TERMINAL BOARD PANEL	
2-6	704/06	14AWG	47BA-4	EYJ (B)	J3	A	LA4 (B)	TB	2	40	7-3.103	C4	ELECTRICAL T/L CONNECTION	
2-6	704/06	14AWG	47BA-4	LA4 (B)	TB	2	EYJ (B)	J3	A	26C	10-3.27	A3	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	704/06	14AWG	47CA-3	EYJ (B)	J3	C	LA2 (B)	TB	2	40	7-3.103	C4	ELECTRICAL T/L CONNECTION	
2-6	704/06	6AWG	70AE-3	EYJ (B)	J4	E	HC (B)	V2	C	40	7-3.103	B4		
2-6	704/06	12AWG	70AG-2	EYJ (B)	J3	G	HQ (B)	TB1	2	40	7-3.103	C4		
2-6	704/06	12AWG	70BA-2	EYJ (B)	J4	G	MO (B)	/	A	40	7-3.103	A4		
2-6	704/06	6AWG	71AE-3	EYJ (B)	J3	E	HC (B)	V2	B	40	7-3.103	B4		
2-6	704/06	12AWG	71BA-2	EYJ (B)	J4	H	MO (B)	/	B	40	7-3.103	A4		
2-6	704/06	10AWG	72AC-2	EYJ (B)	J3	B	KO (B)	1	1	40	7-3.103	C4		

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 9 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	704/06	6AWG	72AE-3	EYJ (B)	J3	D	HC (B)	V2	A	40	7-3.103	B4	ELECTRICAL T/L CONNECTION	
2-6	704/06	12AWG	72AG-2	EYJ (B)	J3	H	HQ (B)	TB1	1	40	7-3.103	C4		
2-6	704/06	12AWG	72BA-2	EYJ (B)	J4	I	MO (B)	/	C	40	7-3.103	A4		
2-6	704/06	14AWG	73AA-10	EYJ (B)	J4	B	LA4 (B)	TB	1	40	7-3.103	B4		
2-6	704/06	14AWG	73AA-10	LA4 (B)	TB	1	EYJ (B)	J4	B	26C	10-3.27	A3	CEILING LIGHT CIRCUIT "AC CIRCUIT"	SEE SH. 26A (PAGE 10-3.23 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	704/06	14AWG	73AA-12	EYJ (B)	J4	C	HC (B)	V2	D	40	7-3.103	B4	ELECTRICAL T/L CONNECTION	
2-6	704/06	10AWG	73AA-7	EYJ (B)	J4	A	KO (B)	1	2					
2-6	707/04	6AWG	R15	HC (B)	V1	B	MH (B)	/	3	13	9-3.17	B4	HVAC PACKAGE	
2-6	707/04	6AWG	T15	HC (B)	V1	A	EYJ (B)	J6	B					
2-6	709/06	2/0AWG	R22	MQ (B)	/	DC-	MP (B)	/	/	14	4-3.25	D(3-6)	BRAKE RESISTOR	
2-6	709/06	2/0AWG	R23	MQ (B)	/	HG	MP (B)	/	/					
2-6	709/06	2/0AWG	T21	MQ (B)	/	RDB	MP (B)	/	/					
2-6	710/06	2/0AWG	R20	MQ (B)	/	HG	MP (B)	/	/					
2-6	710/06	2/0AWG	R21	MQ (B)	/	DC-	MP (B)	/	/					
2-6	710/06	2/0AWG	T20	MQ (B)	/	RDB	MP (B)	/	/					
2-6	715/04	6AWG	R15	HC (B)	V1	B	MH (B)	/	3	13	9-3.17	B4	HVAC PACKAGE	
2-6	715/04	6AWG	T15	HC (B)	V1	A	EYJ (B)	J6	B					
2-6	716/06	16AWG	44BA-2	FV (B)	TB2	8	KR (B)	TB1	17	46A	5-3.177	B3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	44BB-39	FV (B)	TB3	4	KT (B)	TB2	21	46A	5-3.177	B6		
2-6	716/06	16AWG	44BC-39	FV (B)	TB4	5	EYJ (B)	J11	BF	46A	5-3.177	A3		
2-6	716/06	10AWG	48BA-3	LE2 (B)	TB	3	EYJ (B)	J5	35	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	716/06	16AWG	54AA-2	KF (B)	TB1	4	KB (B)	TB1	9	46A	16-3.27	B4	FRICT. BRAKE FAULT ANNUNC. RELAIES PANEL	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	54BA-1	KF (B)	TB1	1	EYJ (B)	J11	BH					
2-6	716/06	16AWG	54BA-2	KF (B)	TB1	1	KT (B)	TB2	16					
2-6	716/06	16AWG	54CA-1	KF (B)	TB1	2	EYJ (B)	J11	AY					
2-6	716/06	16AWG	54CA-2	KF (B)	TB1	2	KT (B)	TB2	15					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 10 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	716/06	16AWG	54DA-1	KF (B)	TB1	3	EYJ (B)	J11	AX	46A	16-3.27	B4	FRICT. BRAKE FAULT ANNUNC. RELAIES PANEL	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	54DA-2	KF (B)	TB1	3	KT (B)	TB2	14					
2-6	716/06	16AWG	55KA-6	FV (B)	TB2	21	EYJ (B)	J12	h	46A	5-3.177	B6	TERMINAL BOARD PANEL	
2-6	716/06	16AWG	55QC-1	FV (B)	TB2	4	KB (B)	TB2	15	46A	5-3.177	A3		
2-6	716/06	16AWG	55SC-1	FV (B)	TB1	15	EYJ (B)	J11	AN	46A	5-3.177	B5		
2-6	716/06	16AWG	56AD-16	FV (B)	TB2	15	KB (B)	TB2	21	46A	5-3.177	A3		
2-6	716/06	16AWG	58BA-4	LB3 (B)	/	2	LB1 (B)	/	2	27D	10-3.37	A3	TURN LIGHT	SEE SH. 27B (PAGE 10-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	12AWG/TH53	80JA-2	FN (B)	EPA1	b6	KB (B)	TB3	15	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	83AA-1	MD (B)	DP	A	MP (B)	M2	g	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-6	716/06	16AWG	83BA-1	MD (B)	DP	B	MP (B)	M2	h					
2-6	716/06	16AWG	83CA-1	MD (B)	DP	C	MP (B)	M2	j					
2-6	716/06	16AWG	83DA-1	MD (B)	DP	D	MP (B)	M2	K					
2-6	716/06	16AWG	83EA-1	MD (B)	DP	E	MP (B)	M2	m					
2-6	716/06	16AWG	83FA-1	MD (B)	DP	F	MP (B)	M2	n					
2-6	716/06	16AWG	83GA-1	MD (B)	DP	G	MP (B)	M2	p					
2-6	716/06	16AWG	83HA-1	MD (B)	DP	H	MP (B)	M2	q					
2-6	716/06	16AWG	83JA-1	MD (B)	DP	J	MP (B)	M2	r					
2-6	716/06	16AWG	83KA-1	MD (B)	DP	K	MP (B)	M2	s					
2-6	716/06	16AWG	83LA-1	MD (B)	DP	L	MP (B)	M2	t					
2-6	716/06	16AWG	83MA-1	MD (B)	DP	M	MP (B)	M2	u					
2-6	716/06	16AWG	83NA-1	MD (B)	DP	N	MP (B)	M2	v					
2-6	716/06	16AWG	83PA-1	MD (B)	DP	P	MP (B)	M2	w					
2-6	716/06	16AWG	83QA-1	MD (B)	DP	Q	MP (B)	M2	x					
2-6	716/06	16AWG	83RA-1	MD (B)	DP	R	MP (B)	M2	y					
2-6	716/06	16AWG	83SA-1	MD (B)	DP	S	MP (B)	M2	z					
2-6	716/06	16A/83TH1	83TA-1	MD (B)	DP	W	MP (B)	M2	Q					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 11 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	716/06	3X16AWG	83TH-1	MD (B)	DP	Z	MP (B)	M2	X	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-6	716/06	16A/83TH1	83UA-1	MD (B)	DP	X	MP (B)	M2	R					
2-6	716/06	16A/83TH1	83VA-1	MD (B)	DP	Y	MP (B)	M2	V					
2-6	716/06	16AWG	ET049-10	FV (B)	TB1	1	KQ (B)	TLN1	/	46A	5-3.177	A4	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	12AWG/TH53	ET051-3	FN (B)	EPA1	c6	KB (B)	TB3	14	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	
2-6	716/06	12AWG/TH52	ET053-4	FV (B)	TB2	13	KQ (B)	TB9	15	46A	5-3.177	A3	TERMINAL BOARD PANEL	
2-6	716/06	12AWG/TH52	ET054-4	FV (B)	TB2	14	KQ (B)	TB9	14	46A	5-3.177	A3		
2-6	716/06	16AWG	ET057-3	FV (B)	TB2	16	KB (B)	TB3	12	46A	5-3.177	A3		
2-6	716/06	16AWG	ET058-3	FV (B)	TB2	17	KB (B)	TB3	11	46A	5-3.177	A3		
2-6	716/06	16AWG	NB29-3	FV (B)	TB1	3	FS1 (B)	B12	2	46A	5-3.177	A4		
2-6	716/06	10AWG	NB55-2	LE2 (B)	TB	1	EYJ (B)	J5	36	26D	10-3.29	A4	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	NB8-7	LB3 (B)	/	1	LB1 (B)	/	1	27D	10-3.37	A3	TURN LIGHT	SEE SH. 27B (PAGE 10-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	16AWG	SPARE36	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE38	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE39	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE40	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE46	FV (B)	/	/	EYJ (B)	J12	g	/	/	/	/	
2-6	716/06	16AWG	SPARE48	FV (B)	/	/	EYJ (B)	J12	i	/	/	/	/	
2-6	716/06	16AWG	SPARE49	FV (B)	/	/	EYJ (B)	J12	j	/	/	/	/	
2-6	716/06	16AWG	SPARE50	FV (B)	/	/	EYJ (B)	J12	k	/	/	/	/	
2-6	716/06	16AWG	SPARE56	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE57	FV (B)	/	/	KB (B)	/	/	/	/	/	/	
2-6	716/06	16AWG	SPARE58	FV (B)	/	/	KB (B)	/	/	/	/	/	/	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 12 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	716/06	2X12AWG	TH-52	FV (B)	/	/	KQ (B)	TB9	13	46A	5-3.177	B5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	716/06	2X12AWG	TH-53	FN (B)	/	/	KB (B)	TB3	17	46A	16-3.27	A4	BRAKE ELECTRONIC CONTROL UNIT	
2-6	716/06	16AWG	X29-34	FV (B)	TB1	20	EYJ (B)	J11	AP	46A	5-3.177	B5	TERMINAL BOARD PANEL	
2-6	716/06	16AWG	X29-5	FV (B)	TB2	18	KR (B)	TB1	7÷8					
2-6	716/06	16AWG	X29-8	FV (B)	TB2	18	FG (B)	/	N					
2-6	CRT/01	16AWG	54EA-1	FS1 (B)	B12	1	KT (B)	TB2	12	46A	16-3.27	C5	CUT OUT BRAKE VALVE	
2-6	CRT/01	16AWG	NB29-3	FS1 (B)	B12	2	FV (B)	TB1	3					
2-6	CRT/02	12AWG	70BA-2	EYJ (B)	J4	G	MO (B)	/	A	40	7-3.103	A4	ELECTRICAL T/L CONNECTION	
2-6	CRT/02	12AWG	71BA-2	EYJ (B)	J4	H	MO (B)	/	B					
2-6	CRT/02	12AWG	72BA-2	EYJ (B)	J4	I	MO (B)	/	C					
2-6	CRT/03	10AWG	72AC-2	KO (B)	1	1	EYJ (B)	J3	B	40	5-3.173	D2	CONVENIENCE OUTLETS	
2-6	CRT/03	10AWG	72AC-3	KO (B)	1	1	KO (B)	2	1					
2-6	CRT/03	10AWG	72AC-3	KO (B)	2	1	KO (B)	1	1					
2-6	CRT/03	10AWG	73AA-36	KO (B)	1	2	KO (B)	2	2					
2-6	CRT/03	10AWG	73AA-36	KO (B)	2	2	KO (B)	1	2					
2-6	CRT/03	10AWG	73AA-7	KO (B)	1	2	EYJ (B)	J4	A					
2-6	KPS/08	10AWG	48AA-2	LE3 (A)	TB	3	BG (A)	TB4	2	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	KPS/08	10AWG	48BA-2	EYP (A)	P5	35	BG (A)	TB4	1	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-6	KPS/08	16AWG	54QA-3	EYP (A)	P5	26	FB (A)	/	10	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KPS/08	16AWG	54RA-3	EYP (A)	P5	25	FB (A)	/	12					
2-6	KPS/08	16AWG	54SA-3	EYP (A)	P5	24	FB (A)	/	11					
2-6	KPS/08	16AWG	54TA-3	EYP (A)	P5	15	FB (A)	/	16					
2-6	KPS/08	16AWG	54VA-3	EYP (A)	P5	23	FB (A)	/	8					
2-6	KPS/08	16AWG	54WA-3	EYP (A)	P5	22	FB (A)	/	5					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 13 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KPS/08	16AWG	54XA-9	EYP (A)	P5	33	FE (A)	/	D	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KPS/08	16AWG	55KA-2	EYP (A)	P5	32	FE (A)	/	C					
2-6	KPS/08	16AWG	55SB-2	EYP (A)	P5	47	PSA (A)	/	D	46A	7-3.125	B6		
2-6	KPS/08	16AWG	55SD-2	EYP (A)	P5	46	PSA (A)	/	C					
2-6	KPS/08	16AWG	57DA-3	EYP (A)	P5	48	FE (A)	/	A	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	KPS/08	16AWG	81JA-5	EYP (A)	P5	42	FL (A)	/	E	44A	7-3.121	A5		
2-6	KPS/08	16AWG	81KA-5	EYP (A)	P5	43	FL (A)	/	C					
2-6	KPS/08	16AWG	81PB-3	EYP (A)	P5	45	FE (A)	/	B	44A	7-3.121	B5		
2-6	KPS/08	16AWG	81XA-2	EYP (A)	P5	37	BG (A)	TB4	8	38C	7-3.101	A6	ELECTRICAL T/L CONNECTION	SEE SH. 38B (PAGE 7-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	KPS/08	16AWG	83WA-2	EYP (A)	P5	50	MS (A)	TBKN	A	38A	7-3.97	A7	ELECTRICAL T/L CONNECTION	
2-6	KPS/08	16AWG	83WB-1	EYP (A)	P5	49	MS (A)	TBKN	B					
2-6	KPS/08	18A/84TH10	84QA-2	EYP (A)	P5	60	PSA (A)	/	V	38A	7-3.97	B7		
2-6	KPS/08	18A/84TH10	84RA-2	EYP (A)	P5	59	PSA (A)	/	U					
2-6	KPS/08	18A/84TH10	84SA-2	EYP (A)	P5	58	PSA (A)	/	T					
2-6	KPS/08	18A/84TH10	84TA-2	EYP (A)	P5	57	PSA (A)	/	S					
2-6	KPS/08	4X18AWG	84TH-10	EYP (A)	P5	56	PSA (A)	/	R					
2-6	KPS/08	4X18AWG	84TH-13	EYP (A)	P5	51	PSA (A)	/	K	38A	7-3.97	A7		
2-6	KPS/08	18A/84TH13	84UA-2	EYP (A)	P5	55	PSA (A)	/	P	38A	7-3.97	B7		
2-6	KPS/08	18A/84TH13	84VA-2	EYP (A)	P5	54	PSA (A)	/	N					
2-6	KPS/08	18A/84TH13	84WA-2	EYP (A)	P5	53	PSA (A)	/	M	38A	7-3.97	A7		
2-6	KPS/08	18A/84TH13	84XA-2	EYP (A)	P5	52	PSA (A)	/	L					
2-6	KPS/08	6AWG	C16-1	EYP (A)	P1	B	BG (A)	TB3	4	10	7-3.21	D4		
2-6	KPS/08	16AWG	NB23-6	EYP (A)	P5	44	FL (A)	/	A	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	KPS/08	6AWG	NB50	EYP (A)	P1	D	BG (A)	TBN1	7	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 14 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KPS/08	10AWG	NB54-1	LE3 (A)	TB	1÷2	BG (A)	TBN1	6	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY"	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449
2-6	KPS/08	10AWG	NB55-1	EYP (A)	P5	36	BG (A)	TBN1	8	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-6	KPS/08	6AWG	NB58-3	EYP (A)	P2	C	BG (A)	TB5	3	10	7-3.21	A4		
2-6	KPS/08	6AWG	NB60	EYP (A)	P2	D	BG (A)	TBN2	2	10	7-3.21	A4		
2-6	KPS/08	6AWG	PB58	EYP (A)	P2	B	BG (A)	TB5	2	10	7-3.21	B4		
2-6	KPS/08	2AWG	S2	EYP (A)	P1	C	BG (A)	F4	/	10	7-3.21	C4		
2-6	KPS/08	6AWG	S4	EYP (A)	P2	A	BG (A)	F5	/	10	7-3.21	B4		
2-6	KPS/08	16AWG	SPARE59	EYP (A)	P5	14	BG (A)	/	/	/	/	/	/	
2-6	KPS/08	16AWG	SPARE60	EYP (A)	P5	38	BG (A)	/	/	/	/	/	/	
2-6	KPS/08	16AWG	SPARE61	EYP (A)	P5	39	BG (A)	/	/	/	/	/	/	
2-6	KPS/08	16AWG	SPARE62	EYP (A)	P5	40	BG (A)	/	/	/	/	/	/	
2-6	KPS/08	16AWG	SPARE63	EYP (A)	P5	41	BG (A)	/	/	/	/	/	/	
2-6	KPS/08	2X16AWG	TH-54	EYP (A)	P5	29	FB (A)	/	/	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KPS/08	2AWG	X2-1	EYP (A)	P1	A	BG (A)	TB3	3	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-6	KPS/08	16AWG	X29-16	EYP (A)	P5	31	FE (A)	/	H	46A	7-3.125	C6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KPS/08	16AWG	X29-37	EYP (A)	P5	34	PSA (A)	/	A	46A	7-3.125	B6		
2-6	KPS/08	16AWG	X29-41	EYP (A)	P5	30	FE (A)	/	F	46A	7-3.125	C6		
2-6	KZR/10	12AWG	14BB-2	SC5 (A)	TB	2	EYP (A)	P7	30	22D	8-3.51	D6	CUT OUT SWITCH PANEL	SEE SH. 22B (PAGE 8-3.47 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	14BC-4	SC5 (A)	TB	5	EYP (A)	P11	k					
2-6	KZR/10	12AWG	14CB-2	SC5 (A)	TB	4	EYP (A)	P7	31					
2-6	KZR/10	16AWG	17GA-2	AA (A)	P9	J	KR (A)	TB4	4	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	17HA-2	AA (A)	P9	K	KR (A)	TB4	3					
2-6	KZR/10	16AWG	18AA-12	AA (A)	P2	E	KB (A)	TB4	17					
2-6	KZR/10	16AWG	18AA-14	AA (A)	P2	b	KR (A)	TB1	7					
2-6	KZR/10	16AWG	18AA-20	AA (A)	P2	s	EYP (A)	P12	R					
2-6	KZR/10	16AWG	18BA-12	AA (A)	P2	p	KB (A)	TB4	16					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 15 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	16AWG	18BA-15	AA (A)	P2	c	KR (A)	TB1	8	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	18BA-20	AA (A)	P2	r	EYP (A)	P12	P					
2-6	KZR/10	16AWG	18DA-13	AA (A)	P2	d	KR (A)	TB1	4					
2-6	KZR/10	16AWG	18DA-14	AA (A)	P2	h	KB (A)	TB3	16					
2-6	KZR/10	16AWG	18DA-22	AA (A)	P2	a	EYP (A)	P12	M					
2-6	KZR/10	16AWG	18EA-12	AA (A)	P2	j	KB (A)	TB3	17					
2-6	KZR/10	16AWG	18EA-15	AA (A)	P2	e	KR (A)	TB1	5					
2-6	KZR/10	16AWG	18EA-20	AA (A)	P2	k	EYP (A)	P12	N					
2-6	KZR/10	16AWG	26AA-10	AA (A)	P2	U	EYP (A)	P12	S					
2-6	KZR/10	16AWG	26AA-7	AA (A)	P2	T	KQ (A)	TB3	5					
2-6	KZR/10	16AWG	26BA-2	AA (A)	P3	L	KQ (A)	TB1	14					
2-6	KZR/10	16AWG/TH03	35AA-2	CH (A)	TB	2	EYP (A)	P10	48	31A	11-3.35	A6	EXTERIOR SPEAKER	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH03	35BA-2	CH (A)	TB	1	EYP (A)	P10	47					
2-6	KZR/10	16AWG	35KA-3	AA (A)	P4	h	KR (A)	TB2	18	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	35KB-4	AA (A)	P4	g	CW (A)	TB2	20					
2-6	KZR/10	16AW/TH142	35LA-2	PA (A)	P1	B3	CB (A)	J2	35	51E	17-3.63	G6	ATCS DIGITAL VOICE ANNUNCIATION	
2-6	KZR/10	16AW/TH142	35MA-2	PA (A)	P1	A4	CB (A)	J2	36					
2-6	KZR/10	16AWG	35NA-2	PA (A)	P1	B2	CB (A)	J2	9					
2-6	KZR/10	16AW/TH138	42NA-10	AA (A)	P10	Z	EYP (A)	P12	A	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	
2-6	KZR/10	16AW/TH136	42NA-3	AA (A)	P10	b	AC (A)	A1-P1	Z					
2-6	KZR/10	16AW/TH138	42PA-10	AA (A)	P10	f	EYP (A)	P12	B					
2-6	KZR/10	16AW/TH136	42PA-3	AA (A)	P10	c	AC (A)	A1-P1	X					
2-6	KZR/10	16AW/TH141	42QA-10	AA (A)	P10	P	EYP (A)	P12	D					
2-6	KZR/10	16AW/TH133	42QA-3	AA (A)	P10	H	AC (A)	A1-P1	Y					
2-6	KZR/10	16AW/TH141	42RA-10	AA (A)	P10	R	EYP (A)	P12	E					
2-6	KZR/10	16AW/TH133	42RA-3	AA (A)	P10	J	AC (A)	A1-P1	U					
2-6	KZR/10	16AWG	46KA-5	AA (A)	P2	F	KQ (A)	TB6	11					
2-6	KZR/10	14AWG	48AA-5	LE2 (A)	TB	3	LE3 (A)	TB	3	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 16 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	16AWG	48AG-2	LE2 (A)	TB	4	KQ (A)	TB1	23	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH61	49AA-5	AW (A)	TB7	9	EYP (A)	P11	D	35	17-3.37	C5	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	16AW/TH143	49AA-9	AW (A)	TB7	9	KX (A)	TB1	11					
2-6	KZR/10	16AWG/TH61	49BA-5	AW (A)	TB7	10	EYP (A)	P11	C					
2-6	KZR/10	16AW/TH143	49BA-9	AW (A)	TB7	10	KX (A)	TB1	12					
2-6	KZR/10	16AWG	56DC-1	AW (A)	TB7	23	KT (A)	TB1	5	47A	17-3.53	C5	ATCS TERMINAL BOARD PANEL	SEE SH. 47 (PAGE 17-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	56DC-3	AW (A)	TB7	23	EYP (A)	P12	a					
2-6	KZR/10	16AWG/TH90	64AA-6	AA (A)	P4	V	KQ (A)	TB8	8	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH90	64AE-3	AA (A)	P4	U	KQ (A)	TB8	15					
2-6	KZR/10	16AWG	64CA-2	AA (A)	P2	X	KQ (A)	TB8	19					
2-6	KZR/10	16AWG	66BF-10	AA (A)	P4	N	EYP (A)	P11	AS					
2-6	KZR/10	16AWG	75BA-10	AA (A)	P10	G	EYP (A)	P12	T					
2-6	KZR/10	16AWG	75BA-2	AA (A)	P10	W	KQ (A)	TB2	14					
2-6	KZR/10	16AWG	75GA-10	AA (A)	P3	h	EYP (A)	P12	J					
2-6	KZR/10	16AWG	75GA-3	AA (A)	P3	f	KH (A)	TB7	9					
2-6	KZR/10	16AWG	75GB-10	AA (A)	P10	K	EYP (A)	P12	K					
2-6	KZR/10	16AWG	75GB-2	AA (A)	P10	A	AC (A)	A2-P1	4					
2-6	KZR/10	16AWG	75JA-10	AA (A)	P10	F	EYP (A)	P12	L					
2-6	KZR/10	16AWG	75JA-3	AA (A)	P10	B	AC (A)	A2-P1	2					
2-6	KZR/10	16AWG	88JA-1	AW (A)	TB1	1	KT (A)	TB1	17	38C	17-3.41	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 38B (PAGE 17-3.39 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	88JA-3	AW (A)	TB1	1	EYP (A)	P11	BA					
2-6	KZR/10	16AWG	88KA-2	AA (A)	P3	r	KB (A)	TB12	12	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	88LA-2	AA (A)	P10	S	KB (A)	TB12	13					
2-6	KZR/10	16AWG	88MA-11	AA (A)	P10	U	EYP (A)	P12	Z					
2-6	KZR/10	16AWG	88MA-2	AA (A)	P10	N	KB (A)	TB12	11					
2-6	KZR/10	12AWG	89CA-1	AA (A)	P2	S	EYP (A)	P9	19	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 17 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	16AWG	89DA-1	AA (A)	P2	M	EYP (A)	P12	H	51F	17-3.65	C(6-7)	ATCS "VOBC"	SEE SH. 51C (PAGE 17-3.59 OR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	89FA-1	AA (A)	P2	D	EYP (A)	P9	15	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	89GA-1	AA (A)	P2	B	EYP (A)	P9	34					
2-6	KZR/10	12AWG	89HA-1	AA (A)	P4	F	EYP (A)	P9	5					
2-6	KZR/10	12AWG	89JA-1	AA (A)	P2	L	AB (A)	P1	K	51F	17-3.65	C(6-7)	ATCS "VOBC"	SEE SH. 51C (PAGE 17-3.59 OR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH87	90FA-2	AW (A)	TB3	6	AE (A)	P1	F	51E	17-3.63	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH87	90GA-2	AW (A)	TB3	5	AE (A)	P1	E					
2-6	KZR/10	16AWG	90HA-2	AW (A)	TB3	4	AE (A)	P1	C					
2-6	KZR/10	16AWG	90JA-2	AW (A)	TB3	3	AE (A)	P1	B					
2-6	KZR/10	16AWG	90KA-2	AW (A)	TB3	2	AE (A)	P1	K					
2-6	KZR/10	16AWG	90LA-2	AW (A)	TB3	1	AE (A)	P1	J					
2-6	KZR/10	16AWG	91AA-2	AW (A)	TB9	1	AN (A)	P1	P	51E	17-3.63	D7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	91AA-3	AW (A)	TB9	1	EYP (A)	P12	BF					
2-6	KZR/10	16AWG	91BA-2	AW (A)	TB9	2	AN (A)	P1	R					
2-6	KZR/10	16AWG	91BA-3	AW (A)	TB9	2	EYP (A)	P12	BE					
2-6	KZR/10	16AWG	91CA-2	AW (A)	TB9	3	AN (A)	P1	S					
2-6	KZR/10	16AWG	91CA-3	AW (A)	TB9	3	EYP (A)	P12	BD					
2-6	KZR/10	16AWG	91DA-2	AW (A)	TB9	4	AN (A)	P1	T					
2-6	KZR/10	16AWG	91DA-3	AW (A)	TB9	4	EYP (A)	P12	BC					
2-6	KZR/10	16AWG	91EA-2	AW (A)	TB9	5	AN (A)	P1	U					
2-6	KZR/10	16AWG	91EA-3	AW (A)	TB9	5	EYP (A)	P12	BB					
2-6	KZR/10	16AWG	91FA-2	AW (A)	TB9	6	AN (A)	P1	p					
2-6	KZR/10	16AWG	91FA-3	AW (A)	TB9	6	EYP (A)	P12	BA					
2-6	KZR/10	16AWG	91GA-2	AW (A)	TB9	7	AN (A)	P1	n					
2-6	KZR/10	16AWG	91GA-3	AW (A)	TB9	7	EYP (A)	P12	AZ					
2-6	KZR/10	16AWG	91HA-2	AW (A)	TB9	8	AN (A)	P1	V					
2-6	KZR/10	16AWG	91HA-3	AW (A)	TB9	8	EYP (A)	P12	AY					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 18 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	16AWG	91JA-2	AW (A)	TB9	9	AN (A)	P1	N	51E	17-3.63	D7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	91JA-3	AW (A)	TB9	9	EYP (A)	P12	AX					
2-6	KZR/10	16AWG	91KA-2	AW (A)	TB9	10	AN (A)	P1	L					
2-6	KZR/10	16AWG	91KA-3	AW (A)	TB9	10	EYP (A)	P12	AW					
2-6	KZR/10	16AWG	91LA-2	AW (A)	TB9	11	AN (A)	P1	g					
2-6	KZR/10	16AWG	91LA-3	AW (A)	TB9	11	EYP (A)	P12	AV					
2-6	KZR/10	16AWG	91MA-2	AW (A)	TB9	12	AN (A)	P1	h					
2-6	KZR/10	16AWG	91MA-3	AW (A)	TB9	12	EYP (A)	P12	AU					
2-6	KZR/10	16AWG	91TA-4	AA (A)	P9	k	EYP (A)	P12	AT	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	91TB-2	AA (A)	P9	j	AN (A)	P1	G					
2-6	KZR/10	16AWG	92HA-30	AA (A)	/	/	EYP (A)	P12	AL					
2-6	KZR/10	16AWG	92JA-30	AA (A)	/	/	EYP (A)	P12	AM					
2-6	KZR/10	16AWG	92KA-30	AA (A)	/	/	EYP (A)	P12	AN					
2-6	KZR/10	16AWG	92LA-30	AA (A)	/	/	EYP (A)	P12	AP					
2-6	KZR/10	16AWG	92MA-30	AA (A)	/	/	EYP (A)	P12	AR					
2-6	KZR/10	16AWG	92NA-30	AA (A)	/	/	EYP (A)	P12	AS					
2-6	KZR/10	16AWG	93AA-1	AW (A)	TB10	12	AC (A)	A2-P1	51	51E	17-3.63	C7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	93AA-2	AW (A)	TB10	12	EYP (A)	P12	BH					
2-6	KZR/10	16AWG	93BA-1	AW (A)	TB10	11	AC (A)	A2-P1	50					
2-6	KZR/10	16AWG	93BA-2	AW (A)	TB10	11	EYP (A)	P12	BJ					
2-6	KZR/10	16AWG	93CA-1	AW (A)	TB10	10	AC (A)	A2-P1	49					
2-6	KZR/10	16AWG	93CA-2	AW (A)	TB10	10	EYP (A)	P12	BK					
2-6	KZR/10	16AWG	93DA-1	AW (A)	TB10	9	AC (A)	A2-P1	48					
2-6	KZR/10	16AWG	93DA-2	AW (A)	TB10	9	EYP (A)	P12	BL					
2-6	KZR/10	16AWG	93EA-1	AW (A)	TB10	8	AC (A)	A2-P1	33					
2-6	KZR/10	16AWG	93EA-2	AW (A)	TB10	8	EYP (A)	P12	BM					
2-6	KZR/10	16AWG	93FA-1	AW (A)	TB10	7	AC (A)	A2-P1	32	51E	17-3.63	B7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	93FA-2	AW (A)	TB10	7	EYP (A)	P12	BN					
2-6	KZR/10	16AWG	93GA-1	AW (A)	TB10	6	AC (A)	A2-P1	31					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 19 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	16AWG	93GA-2	AW (A)	TB10	6	EYP (A)	P12	BP	51E	17-3.63	B7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	93HA-1	AW (A)	TB10	5	AC (A)	A2-P1	30					
2-6	KZR/10	16AWG	93HA-2	AW (A)	TB10	5	EYP (A)	P12	BR					
2-6	KZR/10	16AWG	93JA-1	AW (A)	TB10	4	AC (A)	A2-P1	29					
2-6	KZR/10	16AWG	93JA-2	AW (A)	TB10	4	EYP (A)	P12	BS					
2-6	KZR/10	16AWG	93KA-1	AW (A)	TB10	3	AC (A)	A2-P1	28					
2-6	KZR/10	16AWG	93KA-2	AW (A)	TB10	3	EYP (A)	P12	BT					
2-6	KZR/10	16AWG	93LA-1	AW (A)	TB10	2	AC (A)	A2-P1	27					
2-6	KZR/10	16AWG	93LA-2	AW (A)	TB10	2	EYP (A)	P12	BU					
2-6	KZR/10	16AWG	93MA-1	AW (A)	TB10	1	AC (A)	A2-P1	26					
2-6	KZR/10	16AWG	93MA-2	AW (A)	TB10	1	EYP (A)	P12	BV					
2-6	KZR/10	16AWG	94LA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6		
2-6	KZR/10	16AWG	94MA-2	AW (A)	/	/	KB (A)	/	/					
2-6	KZR/10	16AWG	94NA-2	AW (A)	/	/	KB (A)	/	/					
2-6	KZR/10	16AWG	94PA-2	AW (A)	/	/	KB (A)	/	/					
2-6	KZR/10	16AWG	94QA-2	AW (A)	/	/	KB (A)	/	/					
2-6	KZR/10	16AWG	94QA-30	AA (A)	/	/	EYP (A)	P12	q	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	94RA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	16AWG	94RA-30	AA (A)	/	/	EYP (A)	P12	p	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	
2-6	KZR/10	16AWG	94SA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARDPANEL	
2-6	KZR/10	16AWG	94SA-30	AA (A)	/	/	EYP (A)	P12	n	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	94TA-30	AA (A)	/	/	EYP (A)	P12	m					
2-6	KZR/10	16AWG	95GA-2	AA (A)	P2	m	AB (A)	P1	B					
2-6	KZR/10	16AWG	95GA-30	AA (A)	P2	n	EYP (A)	P12	v					
2-6	KZR/10	16AWG	95HA-30	AA (A)	P3	C	EYP (A)	P12	w					
2-6	KZR/10	16AWG/TH97	95JA-30	AA (A)	/	/	EYP (A)	P12	x					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 20 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	18AWG/TH97	95JA-30	AA (A)	CU1	2	PA (A)	J2	3	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG/TH97	95KA-30	AA (A)	/	/	EYP (A)	P12	y					
2-6	KZR/10	18AWG/TH97	95KA-30	AA (A)	CU1	3	PA (A)	J2	2					
2-6	KZR/10	16AWG	95TA-30	AA (A)	/	/	EYP (A)	P12	b					
2-6	KZR/10	18AWG/TH97	95TA-30	AA (A)	CU1	4	PA (A)	J2	7					
2-6	KZR/10	16AWG	95UA-30	AA (A)	/	/	EYP (A)	P12	AJ					
2-6	KZR/10	18AWG/TH97	95UA-30	AA (A)	CU1	7	PA (A)	J2	5					
2-6	KZR/10	16AWG	95VA-2	AW (A)	/	/	KB (A)	/	/	51E	17-3.63	F6	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	16AWG	ET019-3	AA (A)	P3	a	KB (A)	TB6	2	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	ET027-6	AA (A)	P10	g	KQ (A)	TB6	22	51E				
2-6	KZR/10	16AWG	ET033-7	AW (A)	TB1	13	KQ (A)	TB5	2	47A	17-3.53	C8	ATCS TERMINAL BOARD PANEL	SEE SH. 47 (PAGE 17-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	ET035-3	AA (A)	P3	b	KB (A)	TB6	3	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET036	AW (A)	TB3	12	KB (A)	TB6	11	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET036-3	AW (A)	TB3	12	EYP (A)	P9	7					
2-6	KZR/10	16AWG	ET037-3	AA (A)	P3	c	KB (A)	TB6	4	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET038	AW (A)	TB3	11	KH (A)	TB3	13	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET038-2	AW (A)	TB3	11	EYP (A)	P9	6					
2-6	KZR/10	16AWG	ET041-6	AA (A)	P10	X	KB (A)	TB1	8	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	ET046-7	AA (A)	P3	k	KQ (A)	TB7	12					
2-6	KZR/10	16AWG	ET047-3	AA (A)	P10	h	KQ (A)	TB10	3					
2-6	KZR/10	12AWG	ET049-25	AA (A)	P10	m	KQ (A)	TLN1	/					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 21 of 23

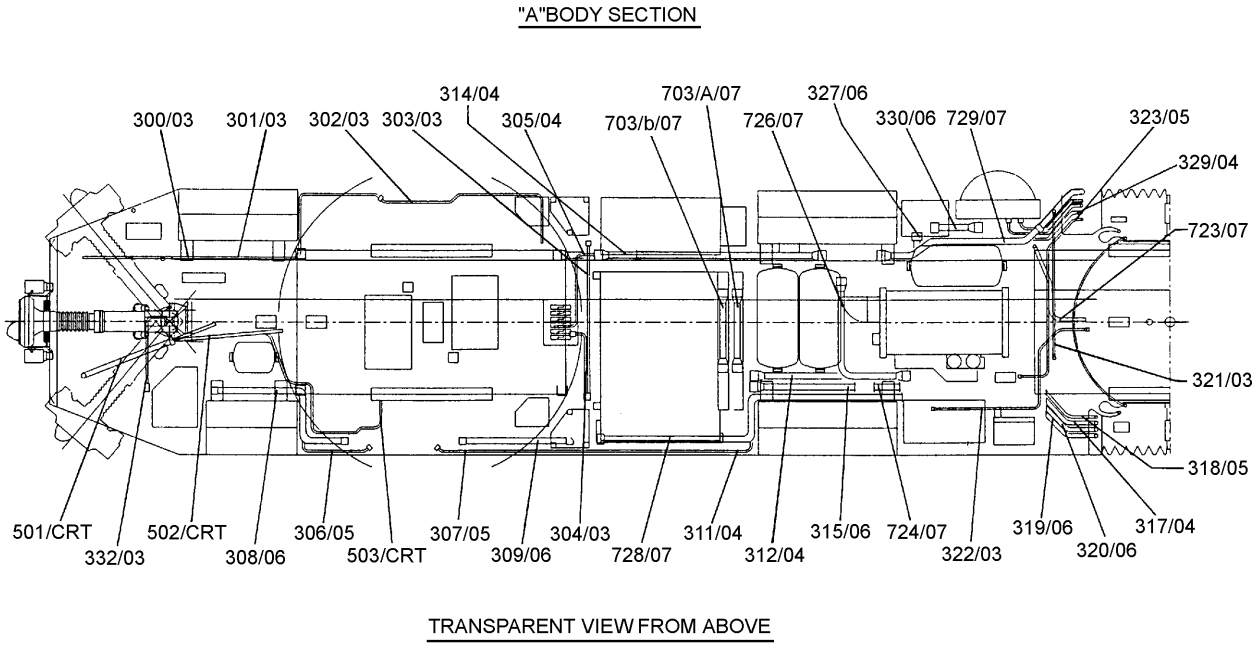
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	12AWG/TH68	ET050-10	AW (A)	TB4	22	EYP (A)	P9	21	29A	17-3.31	B6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG/TH72	ET050-2	AW (A)	TB4	20	KQ (A)	TB9	13					
2-6	KZR/10	16AWG	ET053-4	AA (A)	P3	M	KQ (A)	TB9	22	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	ET054-4	AA (A)	P3	T	KQ (A)	TB9	21					
2-6	KZR/10	16AWG	ET055-4	AA (A)	P2	G	KH (A)	TB5	20					
2-6	KZR/10	16AWG	ET056-4	AA (A)	P2	H	KH (A)	TB5	21					
2-6	KZR/10	16AWG	ET057-2	AA (A)	P2	g	KQ (A)	TB8	17					
2-6	KZR/10	16AWG	ET058-1	AA (A)	P2	f	KH (A)	TB4	7					
2-6	KZR/10	12AWG	ET059-1	AA (A)	P3	G	KQ (A)	TB7	10					
2-6	KZR/10	12AWG	ET059-10	AA (A)	P3	H	EYP (A)	P8	21					
2-6	KZR/10	16AWG	ET060-2	AA (A)	P3	J	KB (A)	TB5	1					
2-6	KZR/10	16AWG	ET061-8	AA (A)	P3	A	KB (A)	TB12	9					
2-6	KZR/10	16AWG	ET062-20	AA (A)	P10	T	EYP (A)	P12	W					
2-6	KZR/10	16AWG	ET062-8	AA (A)	P10	M	KB (A)	TB12	10					
2-6	KZR/10	16AWG	ET064-6	AA (A)	P3	e	KB (A)	TB1	7					
2-6	KZR/10	16AWG	ET066-7	AA (A)	P3	g	KQ (A)	TB2	23					
2-6	KZR/10	16AWG	ET067-3	AA (A)	P2	J	KB (A)	TB2	1					
2-6	KZR/10	12AWG	ET069-28	AA (A)	P10	n	KQ (A)	TLP1	/					
2-6	KZR/10	16AWG	ET073-3	AA (A)	P3	K	KB (A)	TB5	5					
2-6	KZR/10	12AWG/TH72	ET087-1	AW (A)	TB4	19	KQ (A)	TB9	14	29A	17-3.31	B6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG/TH68	ET087-10	AW (A)	TB4	23	EYP (A)	P9	22					
2-6	KZR/10	12AWG	ET089	AW (A)	TB3	10	KH (A)	TB6	1	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET089-2	AW (A)	TB3	10	EYP (A)	P9	4					
2-6	KZR/10	12AWG	ET090	AA (A)	P4	E	KH (A)	TB6	2	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET091	AA (A)	P2	A	KH (A)	TB6	3					
2-6	KZR/10	12AWG	ET092	AA (A)	P2	C	KH (A)	TB6	4					
2-6	KZR/10	12AWG	ET093-10	AA (A)	P2	P	EYP (A)	P9	17	51F	17-3.65	C(6-7)	ATCS "VOBC"	SEE SH. 51C (PAGE 17-3.59FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET094	AA (A)	P2	N	KH (A)	TB6	6					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 22 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	12AW/TH126	ET095	AW (A)	TB3	14	KH (A)	TB6	7	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	12AW/TH127	ET095-1	AW (A)	TB3	14	EYP (A)	P9	1					
2-6	KZR/10	12AW/TH126	ET096	AW (A)	TB3	13	KH (A)	TB6	8					
2-6	KZR/10	12AW/TH127	ET096-1	AW (A)	TB3	13	EYP (A)	P9	2					
2-6	KZR/10	12AWG	ET097	AA (A)	P2	R	KH (A)	TB6	10	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	12AWG	ET098	AW (A)	TB3	20	KT (A)	TB1	21	51D	17-3.61	B5	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	12AWG	ET098-4	AW (A)	TB3	20	EYP (A)	P9	28					
2-6	KZR/10	12AWG	ET099	AW (A)	TB3	18	KH (A)	TB4	2					
2-6	KZR/10	12AWG	ET099-4	AW (A)	TB3	18	EYP (A)	P9	20					
2-6	KZR/10	12AWG	ET100	AW (A)	TB3	19	KH (A)	TB4	3					
2-6	KZR/10	12AWG	ET100-4	AW (A)	TB3	19	EYP (A)	P9	27					
2-6	KZR/10	16AWG	ET101-3	AA (A)	P3	m	KR (A)	TB4	11	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	10AWG	G21	AA (A)	P4	W	MX (A)	A11	/	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	G21-1	AW (A)	TB3	15	MX (A)	A11	/	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	12AWG	NB24	AA (A)	P10	r	KB (A)	NB AUX.	15	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	16AWG	NB42-2	AA (A)	P3	W	KQ (A)	TB1	20	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	14AWG	NB54-6	LE2 (A)	TB	1÷2	LE3 (A)	TB	2	26D	10-3.29	A7	CEILING LIGHT CIRCUIT "EMERGENCY	SEE SH. 26B (PAGE 10-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	2X16AWG	TH-03	CH (A)	TB	3	EYP (A)	P10	46	31A	11-3.35	A6	SPEAKER EXTERIOR	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" AND "B" BODY SECTION ART. SEC. FRONT.	REV. 00 Page 23 of 23

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-6	KZR/10	2X12AWG	TH-126	AW (A)	TB3	15	KH (A)	/	/	51G	17-3.67	B3	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	2X12AWG	TH-127	AW (A)	TB3	15	EYP (A)	P9	3					
2-6	KZR/10	2X16AWG	TH-133	AA (A)	P10	e	AC (A)	A1-P1	V	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	2X16AWG	TH-136	AA (A)	P10	d	AC (A)	A1-P1	W					
2-6	KZR/10	2X16AWG	TH-138	AA (A)	/	TH-13	EYP (A)	P12	C					
2-6	KZR/10	2X16AWG	TH-141	AA (A)	/	TH-13	EYP (A)	P12	F					
2-6	KZR/10	2X16AWG	TH-142	CB (A)	/	/	PA (A)	P1	B4	31A	11-3.35	(CDE)5	COMMUNICATION AMPLIFIER CONTROL UNIT	SEE SH. 31 (PAGE 11-3.33 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	2X16AWG	TH-143	AW (A)	TB7	11	KX (A)	TB1	13	35	17-3.37	C5	ATCS TERMINAL BOARD PANEL	
2-6	KZR/10	2X16AWG	TH-61	AW (A)	TB7	11	EYP (A)	P11	E					
2-6	KZR/10	2X12AWG	TH-68	AW (A)	TB4	21	EYP (A)	P9	23	29A	17-3.31	C6	ATCS TERMINAL BOARD PANEL	SEE SH. 29 (PAGE 17-3.29 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	2X12AWG	TH-72	AW (A)	TB4	21	KQ (A)	TB9	20					
2-6	KZR/10	2X16AWG	TH-87	AW (A)	TB3	7	AE (A)	P1	L	51E	17-3.63	A7	ATCS TERMINAL BOARD PANEL	SEE SH. 51B (PAGE 17-3.57 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-6	KZR/10	2X16AWG	TH-90	AA (A)	/	/	KQ (A)	TB8	6	51E	17-3.63	(AG)(4-6)	ATCS "VOBC"	
2-6	KZR/10	2X16AWG	TH-97	AA (A)	/	/	EYP (A)	P12	z					
2-6	KZR/10	2X18AWG	TH-97	AA (A)	CU1	1	PA (A)	/	/					
2-6	KZR/10	12AWG	X24-2	AA (A)	P10	p	KB (A)	TB12	1	51D	17-3.61	(AB)(4-6)	ATCS "VOBC"	SEE SH. 51A (PAGE 17-3.55 FOR VEHICLES # 1400, 1401, 1403, 1449)



Location Illustration Code: 2-7

Figure 11-1.22 Raceway Location - "A" Body Section – Underframe

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 1 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	300/03	16AWG	55KA-1	KB (A)	TB6	1	FE (A)	/	J	46A	5-3.177	C7	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	300/03	16AWG	ET019-8	KB (A)	TB2	17	FC (A)	A6	2					
2-7	300/03	16AWG	ET068-8	KQ (A)	TLP2	/	FC (A)	A6	1	46A	5-3.177	C1	AUXILIARY RELAY PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	300/03	16AWG	X29-40	KB (A)	TB2	15	FE (A)	/	I	46A	5-3.177	C7	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	301/03	16AWG	55KA-1	KB (A)	TB6	1	FE (A)	/	J					
2-7	301/03	16AWG	ET019-8	KB (A)	TB2	17	FC (A)	A6	2					
2-7	301/03	16AWG	ET068-8	KQ (A)	TLP2	/	FC (A)	A6	1	46A	5-3.177	C1	AUXILIARY RELAY PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	301/03	16AWG	X29-40	KB (A)	TB2	15	FE (A)	/	I	46A	5-3.177	C7	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	302/03	16AWG	55KA-1	KB (A)	TB6	1	FE (A)	/	J					
2-7	302/03	16AWG	ET019-8	KB (A)	TB2	17	FC (A)	A6	2					
2-7	302/03	16AWG	ET068-8	KQ (A)	TLP2	/	FC (A)	A6	1	46A	5-3.177	C1	AUXILIARY RELAY PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	302/03	16AWG	X29-40	KB (A)	TB2	15	FE (A)	/	I					
2-7	303/03	16AWG	55KA-2	FE (A)	/	C	EYP (A)	P5	32	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	303/03	16AWG	57DA-3	FE (A)	/	A	EYP (A)	P5	48	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	303/03	16AWG	81PB-3	FE (A)	/	B	EYP (A)	P5	45					
2-7	303/03	16AWG	X29-16	FE (A)	/	H	EYP (A)	P5	31	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	303/03	16AWG	X29-41	FE (A)	/	F	EYP (A)	P5	30					
2-7	304/03	6AWG	NB56-3	BG (A)	TB5	11	MT-A (A)	PTA	D	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	304/03	6AWG	PB56	BG (A)	TB5	10	MT-A (A)	PTA	A	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	305/04	16AWG	55SB-2	EYP (A)	P5	47	PSA (A)	/	D	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	305/04	16AWG	55SD-2	EYP (A)	P5	46	PSA (A)	/	C	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 2 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	305/04	18A/84TH10	84QA-2	EYP (A)	P5	60	PSA (A)	/	V	38A	7-3.97	B7	ELECTRICAL T/L CONNECTION	
2-7	305/04	18A/84TH10	84RA-2	EYP (A)	P5	59	PSA (A)	/	U					
2-7	305/04	18A/84TH10	84SA-2	EYP (A)	P5	58	PSA (A)	/	T					
2-7	305/04	18A/84TH10	84TA-2	EYP (A)	P5	57	PSA (A)	/	S					
2-7	305/04	4X18AWG	84TH-10	EYP (A)	P5	56	PSA (A)	/	R					
2-7	305/04	4X18AWG	84TH-13	EYP (A)	P5	51	PSA (A)	/	K					
2-7	305/04	18A/84TH13	84UA-2	EYP (A)	P5	55	PSA (A)	/	P					
2-7	305/04	18A/84TH13	84VA-2	EYP (A)	P5	54	PSA (A)	/	N					
2-7	305/04	18A/84TH13	84WA-2	EYP (A)	P5	53	PSA (A)	/	M					
2-7	305/04	18A/84TH13	84XA-2	EYP (A)	P5	52	PSA (A)	/	L					
2-7	305/04	16AWG	X29-37	EYP (A)	P5	34	PSA (A)	/	A	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	306/05	16AWG	41CB-3	BG (A)	TB4	6	KQ (A)	TB7	4	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	306/05	16AWG	45EA-2	BG (A)	TB4	7	KQ (A)	TB3	7					
2-7	306/05	16AWG	56AD-3	BG (A)	TB6	4	KQ (A)	TB5	19	47A	5-3.181	(AB)(5-6)	AUXILIARY BOX	SEE SH. 47 (PAGE 5-3.179 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	306/05	16AWG	56AD-8	BG (A)	TB6	8	KQ (A)	TB5	16					
2-7	306/05	16AWG	ET034-5	BG (A)	TB6	2	KQ (A)	TB5	12					
2-7	306/05	16AWG	ET034-8	BG (A)	TB6	1	KQ (A)	TB5	11					
2-7	306/05	12AWG	NB34	KB (A)	NB AUX.	21	FA (A)	A1.15	B	12C	5-3.63	B(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	306/05	10AWG	S31-2	BB (A)	TB1	7	KB (A)	TB9	10	10	5-3.53	(CD)7	BATTERY CIRCUIT BREAKER PANEL	
2-7	306/05	16AWG	SPARE56	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	306/05	16AWG	SPARE57	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	306/05	16AWG	SPARE58	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	306/05	12AWG	X34-2	KB (A)	TB9	13	FA (A)	A1.15	A	12C	5-3.63	D(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 3 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	307/05	16AWG	41CB-3	BG (A)	TB4	6	KQ (A)	TB7	4	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	307/05	16AWG	45EA-2	BG (A)	TB4	7	KQ (A)	TB3	7					
2-7	307/05	16AWG	56AD-3	BG (A)	TB6	4	KQ (A)	TB5	19	47A	5-3.181	(AB)(5-6)	AUXILIARY BOX	SEE SH. 47 (PAGE 5-3.179 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	307/05	16AWG	56AD-8	BG (A)	TB6	8	KQ (A)	TB5	16					
2-7	307/05	16AWG	ET034-5	BG (A)	TB6	2	KQ (A)	TB5	12					
2-7	307/05	16AWG	ET034-8	BG (A)	TB6	1	KQ (A)	TB5	11					
2-7	307/05	12AWG	NB34	KB (A)	NB AUX.	21	FA (A)	A1.15	B	12C	5-3.63	B(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	307/05	10AWG	S31-2	BB (A)	TB1	7	KB (A)	TB9	10	10	5-3.53	(CD)7	BATTERY CIRCUIT BREAKER PANEL	
2-7	307/05	16AWG	SPARE56	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	307/05	16AWG	SPARE57	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	307/05	16AWG	SPARE58	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	307/05	12AWG	X34-2	KB (A)	TB9	13	FA (A)	A1.15	A	12C	5-3.63	D(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	308/06	6AWG	C15-1	BG (A)	TB3	2	BD (A)	TBCAB	1	10	5-3.67	(ABCD)(5-6)	AUXILIARY BOX	
2-7	308/06	6AWG	NB52	BG (A)	TBN1	5	KB (A)	TB11	1÷8					
2-7	308/06	2/0AWG	NB53	BG (A)	TBN1	2	KB (A)	NB AUX.	1					
2-7	308/06	6AWG	NB59	BG (A)	TBN2	3	KB (A)	TB8	4					
2-7	308/06	2AWG	S1	BG (A)	F3	/	KB (A)	IS	4					
2-7	308/06	6AWG	S3	BG (A)	F6	/	BD (A)	CB36	LINE					
2-7	308/06	2AWG	X1-1	BG (A)	TB3	1	KB (A)	IS	5					
2-7	309/06	6AWG	C15-1	BG (A)	TB3	2	BD (A)	TBCAB	1					
2-7	309/06	6AWG	NB52	BG (A)	TBN1	5	KB (A)	TB11	1÷8					
2-7	309/06	2/0AWG	NB53	BG (A)	TBN1	2	KB (A)	NB AUX.	1					
2-7	309/06	6AWG	NB59	BG (A)	TBN2	3	KB (A)	TB8	4					
2-7	309/06	2AWG	S1	BG (A)	F3	/	KB (A)	IS	4					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 4 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	309/06	6AWG	S3	BG (A)	F6	/	BD (A)	CB36	LINE	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	309/06	2AWG	X1-1	BG (A)	TB3	1	KB (A)	IS	5					
2-7	311/04	16AWG	55KA-2	FE (A)	/	C	EYP (A)	P5	32	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	
2-7	311/04	16AWG	55SB-2	EYP (A)	P5	47	PSA (A)	/	D	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	16AWG	55SD-2	EYP (A)	P5	46	PSA (A)	/	C					
2-7	311/04	16AWG	57DA-3	FE (A)	/	A	EYP (A)	P5	48	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	16AWG	81JA-5	FL (A)	/	E	EYP (A)	P5	42	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	16AWG	81KA-5	FL (A)	/	C	EYP (A)	P5	43					
2-7	311/04	16AWG	81PB-3	FE (A)	/	B	EYP (A)	P5	45	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	18A/84TH10	84QA-2	EYP (A)	P5	60	PSA (A)	/	V	38A	7-3.97	B7	ELECTRICAL T/L CONNECTION	
2-7	311/04	18A/84TH10	84RA-2	EYP (A)	P5	59	PSA (A)	/	U					
2-7	311/04	18A/84TH10	84SA-2	EYP (A)	P5	58	PSA (A)	/	T					
2-7	311/04	18A/84TH10	84TA-2	EYP (A)	P5	57	PSA (A)	/	S					
2-7	311/04	4X18AWG	84TH-10	EYP (A)	P5	56	PSA (A)	/	R					
2-7	311/04	4X18AWG	84TH-13	EYP (A)	P5	51	PSA (A)	/	K					
2-7	311/04	18A/84TH13	84UA-2	EYP (A)	P5	55	PSA (A)	/	P					
2-7	311/04	18A/84TH13	84VA-2	EYP (A)	P5	54	PSA (A)	/	N					
2-7	311/04	18A/84TH13	84WA-2	EYP (A)	P5	53	PSA (A)	/	M					
2-7	311/04	18A/84TH13	84XA-2	EYP (A)	P5	52	PSA (A)	/	L					
2-7	311/04	16AWG	NB23-6	FL (A)	/	A	EYP (A)	P5	44	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	16AWG	X29-16	FE (A)	/	H	EYP (A)	P5	31	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 5 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	311/04	16AWG	X29-37	EYP (A)	P5	34	PSA (A)	/	A	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	311/04	16AWG	X29-41	FE (A)	/	F	EYP (A)	P5	30	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	55KA-2	FE (A)	/	C	EYP (A)	P5	32					
2-7	312/04	16AWG	55SB-2	EYP (A)	P5	47	PSA (A)	/	D	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	55SD-2	EYP (A)	P5	46	PSA (A)	/	C					
2-7	312/04	16AWG	57DA-3	FE (A)	/	A	EYP (A)	P5	48	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	81JA-5	FL (A)	/	E	EYP (A)	P5	42	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	81KA-5	FL (A)	/	C	EYP (A)	P5	43					
2-7	312/04	16AWG	81PB-3	FE (A)	/	B	EYP (A)	P5	45	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	18A/84TH10	84QA-2	EYP (A)	P5	60	PSA (A)	/	V	38A	7-3.97	B7	ELECTRICAL T/L CONNECTION	
2-7	312/04	18A/84TH10	84RA-2	EYP (A)	P5	59	PSA (A)	/	U					
2-7	312/04	18A/84TH10	84SA-2	EYP (A)	P5	58	PSA (A)	/	T					
2-7	312/04	18A/84TH10	84TA-2	EYP (A)	P5	57	PSA (A)	/	S					
2-7	312/04	4X18AWG	84TH-10	EYP (A)	P5	56	PSA (A)	/	R					
2-7	312/04	4X18AWG	84TH-13	EYP (A)	P5	51	PSA (A)	/	K					
2-7	312/04	18A/84TH13	84UA-2	EYP (A)	P5	55	PSA (A)	/	P					
2-7	312/04	18A/84TH13	84VA-2	EYP (A)	P5	54	PSA (A)	/	N					
2-7	312/04	18A/84TH13	84WA-2	EYP (A)	P5	53	PSA (A)	/	M					
2-7	312/04	18A/84TH13	84XA-2	EYP (A)	P5	52	PSA (A)	/	L					
2-7	312/04	16AWG	NB23-6	FL (A)	/	A	EYP (A)	P5	44	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	X29-16	FE (A)	/	H	EYP (A)	P5	31	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 6 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	312/04	16AWG	X29-37	EYP (A)	P5	34	PSA (A)	/	A	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	312/04	16AWG	X29-41	FE (A)	/	F	EYP (A)	P5	30	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	314/04	2AWG	R14	MH (A)	/	5	BE (A)	/	/	13	5-3.67	B6	HIGH VOLTAGE GROUND PLATE	
2-7	314/04	2AWG	T14	KD (A)	TB1	1	BE (A)	/	/	13	5-3.67	D(5-7)	HV FUSES PANEL	
2-7	315/06	2AWG	70AA-1	BG (A)	TBR	1	BE (A)	/	/	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	315/06	12AWG	70BA-1	BE (A)	/	/	EYP (A)	P4	G	40	5-3.151	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	315/06	2AWG	71AA-1	BG (A)	TBS	1	BE (A)	/	/	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	315/06	12AWG	71BA-1	BE (A)	/	/	EYP (A)	P4	H	40	5-3.151	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	315/06	2AWG	72AA-1	BG (A)	TBT	1	BE (A)	/	/	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	315/06	12AWG	72BA-1	BE (A)	/	/	EYP (A)	P4	I	40	5-3.151	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	315/06	2AWG	73AA-1	BG (A)	TBN	1	BE (A)	/	/	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	317/04	6AWG	NB58-3	BG (A)	TB5	3	EYP (A)	P2	C	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	317/04	6AWG	PB58	BG (A)	TB5	2	EYP (A)	P2	B					
2-7	318/05	16AWG	54XA-9	FE (A)	/	D	EYP (A)	P5	33	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	55KA-2	FE (A)	/	C	EYP (A)	P5	32					
2-7	318/05	16AWG	55SB-2	EYP (A)	P5	47	PSA (A)	/	D	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	55SD-2	EYP (A)	P5	46	PSA (A)	/	C					
2-7	318/05	16AWG	57DA-3	FE (A)	/	A	EYP (A)	P5	48	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	81JA-5	FL (A)	/	E	EYP (A)	P5	42	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 7 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	318/05	16AWG	81KA-5	FL (A)	/	C	EYP (A)	P5	43	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	81PB-3	FE (A)	/	B	EYP (A)	P5	45	44A	16-3.23	B6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	83WA-2	MS (A)	TBKN	A	EYP (A)	P5	50	38A	4-3.43	A8	KNIFE SWITCH	
2-7	318/05	16AWG	83WB-1	MS (A)	TBKN	B	EYP (A)	P5	49					
2-7	318/05	18A/84TH10	84QA-2	EYP (A)	P5	60	PSA (A)	/	V	38A	7-3.97	B7	ELECTRICAL T/L CONNECTION	
2-7	318/05	18A/84TH10	84SA-2	EYP (A)	P5	58	PSA (A)	/	T					
2-7	318/05	18A/84TH10	84TA-2	EYP (A)	P5	57	PSA (A)	/	S					
2-7	318/05	4X18AWG	84TH-10	EYP (A)	P5	56	PSA (A)	/	R					
2-7	318/05	4X18AWG	84TH-13	EYP (A)	P5	51	PSA (A)	/	K					
2-7	318/05	18A/84TH13	84UA-2	EYP (A)	P5	55	PSA (A)	/	P					
2-7	318/05	18A/84TH13	84VA-2	EYP (A)	P5	54	PSA (A)	/	N					
2-7	318/05	18A/84TH13	84WA-2	EYP (A)	P5	53	PSA (A)	/	M					
2-7	318/05	18A/84TH13	84XA-2	EYP (A)	P5	52	PSA (A)	/	L					
2-7	318/05	16AWG	NB23-6	FL (A)	/	A	EYP (A)	P5	44	44A	16-3.23	A6	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	X29-16	FE (A)	/	H	EYP (A)	P5	31	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	X29-37	EYP (A)	P5	34	PSA (A)	/	A	46A	7-3.125	B6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	318/05	16AWG	X29-41	FE (A)	/	F	EYP (A)	P5	30	46A	16-3.27	C7	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	319/06	14AWG	47AA-2	BG (A)	TB1	5	LA2 (A)	TB	2	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	319/06	14AWG	47BA-2	BG (A)	TB1	6÷7	LA5 (A)	TB	2					
2-7	319/06	14AWG	47BA-3	BG (A)	TB1	7	EYP (A)	P3	A					
2-7	319/06	14AWG	47CA-2	BG (A)	TB1	8	EYP (A)	P3	C					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 8 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	319/06	10AWG	70AC-2	BG (A)	TB1	2	KO (A)	1	1	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	319/06	6AWG	70AE-2	BG (A)	TB2	6	EYP (A)	P4	E					
2-7	319/06	12AWG	70AG-2	BG (A)	TB1	1	HQ (A)	TB1	2					
2-7	319/06	12AWG	70AG-3	BG (A)	TB1	1	EYP (A)	P3	G					
2-7	319/06	12AWG	70BA-1	BE (A)	/	/	EYP (A)	P4	G	40	5-3.151	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	319/06	6AWG	71AE-2	BG (A)	TB2	5	EYP (A)	P3	E	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	319/06	12AWG	71BA-1	BE (A)	/	/	EYP (A)	P4	H	40	5-3.151	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	319/06	10AWG	72AC-5	BG (A)	TB1	4	EYP (A)	P3	B	40	5-3.151	(BCD)(6-7)	AUXILIARY BOX	
2-7	319/06	6AWG	72AE-2	BG (A)	TB2	4	EYP (A)	P3	D					
2-7	319/06	12AWG	72AG-2	BG (A)	TB1	3	HQ (A)	TB1	1					
2-7	319/06	12AWG	72AG-3	BG (A)	TB1	3	EYP (A)	P3	H					
2-7	319/06	12AWG	72BA-1	BE (A)	/	/	EYP (A)	P4	I					
2-7	319/06	14AWG	73AA-11	BG (A)	TBN	9	EYP (A)	P4	C					
2-7	319/06	10AWG	73AA-2	BG (A)	TBN	4	KO (A)	1	2					
2-7	319/06	14AWG	73AA-4	BG (A)	TBN	5	LA5 (A)	TB	1					
2-7	319/06	10AWG	73AA-6	BG (A)	TBN	7	EYP (A)	P4	A					
2-7	319/06	14AWG	73AA-9	BG (A)	TBN	8	EYP (A)	P4	B					
2-7	320/06	10AWG	48AA-2	BG (A)	TB4	2	LE3 (A)	TB	3	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	320/06	10AWG	48BA-2	BG (A)	TB4	1	EYP (A)	P5	35					
2-7	320/06	16AWG	81XA-2	BG (A)	TB4	8	EYP (A)	P5	37	25A	5-3.105	C4	AUXILIARY BOX	SEE SH. 25 (PAGE 5-3.103 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	320/06	6AWG	C16-1	BG (A)	TB3	4	EYP (A)	P1	B	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	320/06	6AWG	NB50	BG (A)	TBN1	7	EYP (A)	P1	D					
2-7	320/06	10AWG	NB54-1	BG (A)	TBN1	6	LE3 (A)	TB	1÷2					
2-7	320/06	10AWG	NB55-1	BG (A)	TBN1	8	EYP (A)	P5	36					
2-7	320/06	6AWG	NB60	BG (A)	TBN2	2	EYP (A)	P2	D					
2-7	320/06	2AWG	S2	BG (A)	F4	/	EYP (A)	P1	C					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 9 of 11

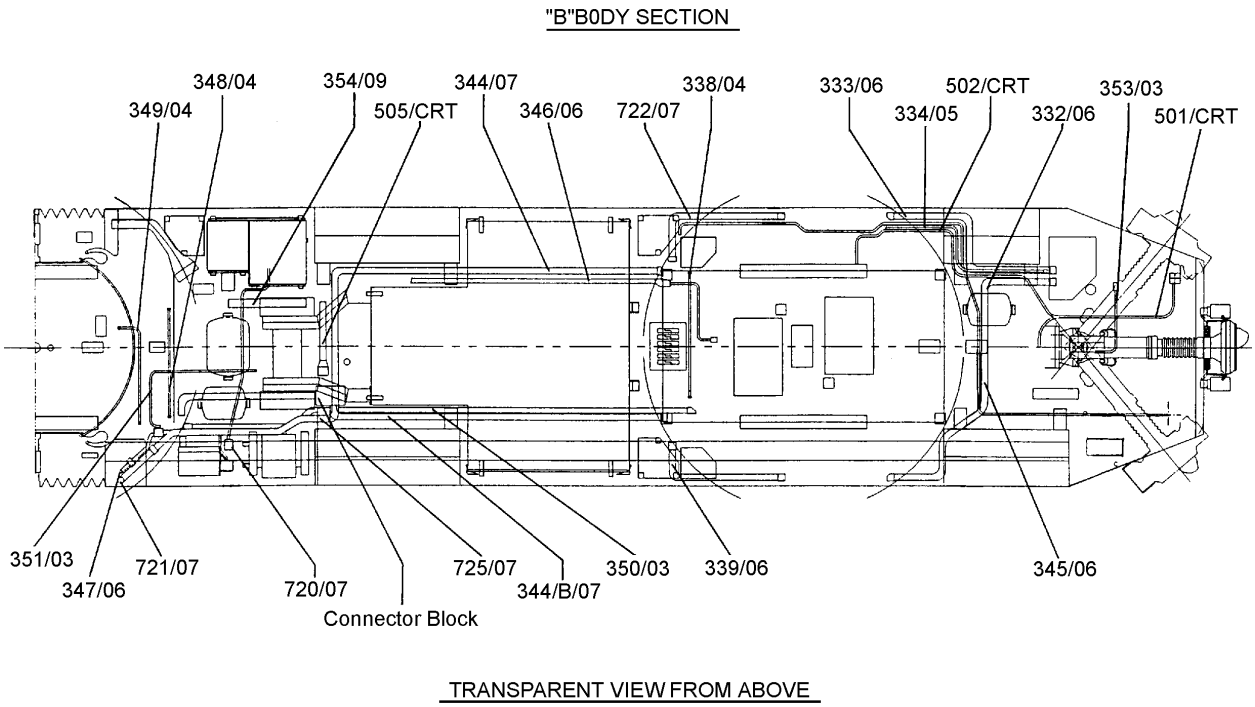
RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	320/06	6AWG	S4	BG (A)	F5	/	EYP (A)	P2	A	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	320/06	2AWG	X2-1	BG (A)	TB3	3	EYP (A)	P1	A					
2-7	321/03	16AWG	83WA-2	MS (A)	TBKN	A	EYP (A)	P5	50	38A	4-3.43	A8	KNIFE SWITCH	
2-7	321/03	16AWG	83WB-1	MS (A)	TBKN	B	EYP (A)	P5	49					
2-7	322/03	6AWG	NB57-3	BG (A)	TB5	7	MT-C (A)	PTC	D	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	322/03	6AWG	PB57	BG (A)	TB5	6	MT-C (A)	PTC	A					
2-7	323/05	262MCM	G25	EY (A)	TB1	E	MH (A)	/	6	13	7-3.27	B5	ELECTRICAL T/L CONNECTION	
2-7	327/06	1AWG	G35	MH (A)	/	1	MS (A)	SHOP PLUG	/	13	5-3.67	B6	HIGH VOLTAGE GROUND PLATE	
2-7	327/06	6AWG	R11	MH (A)	/	2	HC (A)	V1	B					
2-7	327/06	10AWG	T13	KD (A)	TB1	4	FA (A)	A1.16	A	13	5-3.67	D(5-7)	HV FUSES PANEL	
2-7	327/06	2AWG	T14	KD (A)	TB1	1	BE (A)	/	/					
2-7	329/04	6AWG	R11	MH (A)	/	2	HC (A)	V1	B	13	5-3.67	B6	HIGH VOLTAGE GROUND PLATE	
2-7	329/04	6AWG	T11	KD (A)	TB1	2	HC (A)	V1	A	13	5-3.67	D(5-7)	HV FUSES PANEL	
2-7	329/04	6AWG	T15	KD (A)	TB1	3	EYP (A)	P6	B					
2-7	330/06	1AWG	G35	MH (A)	/	1	MS (A)	SHOP PLUG	/	13	5-3.67	B6	HIGH VOLTAGE GROUND PLATE	
2-7	330/06	6AWG	R11	MH (A)	/	2	HC (A)	V1	B					
2-7	330/06	6AWG	T11	KD (A)	TB1	2	HC (A)	V1	A	13	5-3.67	D(5-7)	HV FUSES PANEL	
2-7	330/06	6AWG	T15	KD (A)	TB1	3	EYP (A)	P6	B					
2-7	332/03	10AWG	G50	KZ (A)	TG	/	MX (A)	A50	/	12C	2-3.11	C7	FARE BOX	SEE SH. 12A (PAGE 2-3.9 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	332/03	12AWG	NB15	KZ (A)	TB	-	KB (A)	NB AUX.	9					
2-7	332/03	12AWG	X15-2	KZ (A)	TB	+	KB (A)	TB9	8					
2-7	501/CRT	16AWG	50CA-3	MWA (A)	/	A	KB (A)	TB5	21	42C	3-3.15	A6	ARTICULATION DERAIL SWITCH TRUCK A	SEE SH. 42B (PAGE 3-3.13 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	501/CRT	16AWG	ET048-25	MWA (A)	/	E	KQ (A)	TLNP	/					
2-7	502/CRT	16AWG	50CA-3	MWA (A)	/	A	KB (A)	TB5	21					
2-7	502/CRT	16AWG	ET048-25	MWA (A)	/	E	KQ (A)	TLNP	/					
2-7	503/CRT	16AWG	50CA-3	MWA (A)	/	A	KB (A)	TB5	21					
2-7	503/CRT	16AWG	ET048-25	MWA (A)	/	E	KQ (A)	TLNP	/					
2-7	703/07/CRT	2/0AWG	NB61	BG (A)	TBN1	1	BB (A)	TBN	8	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME	REV. 00 Page 10 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	703/07/CRT	2/0AWG	NB62	BG (A)	TBN2	1	BB (A)	TBN	6	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	703/07/CRT	2/0AWG	PB3	BE (A)	/	/	BB (A)	TB	A	10	5-3.53	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	703/b/CRT	16AWG	40AA-1	BE (A)	A1	A	BB (A)	TB1	3					
2-7	703/b/CRT	16AWG/TH91	41AA-1	BE (A)	A1	W	BB (A)	TB1	1					
2-7	703/b/CRT	16AWG	41DA-1	BE (A)	A1	U	BB (A)	TB1	5					
2-7	703/b/CRT	16AWG	NB93	BE (A)	A1	L	BB (A)	TB1	6					
2-7	703/b/CRT	16AWG	NB94	BE (A)	A1	B	BB (A)	TB1	4					
2-7	703/b/CRT	10AWG	S31-2	KB (A)	TB9	10	BB (A)	TB1	7	12D	5-3.65	D(5-8)	TERMINAL BOARD PANEL	SEE SH. 12B (PAGE 5-3.61 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	703/b/CRT	16AWG	S31-3	BE (A)	A1	Q	BB (A)	TB1	7	10	5-3.53	(ABCD)8	LOW VOLTAGE POWER SUPPLY	
2-7	703/b/CRT	16AWG	S31-4	BE (A)	A1	Y	BB (A)	TB1	7					
2-7	703/b/CRT	2X16AWG	TH-91	BE (A)	A1	V	BB (A)	/	/					
2-7	723/07	3X16AWG	TH-101	AA (A)	P5	I	PSC2 (A)	/	H	51F	17-3.65	C(6-7)	ATCS "VOBC"	SEE SH. 51C (PAGE 17-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	723/07	2X16AWG	TH-107	AA (A)	P7	E	PSC2 (A)	/	N					
2-7	723/07	2X16AWG	TH-110	AA (A)	P7	A	PSC2 (A)	/	S					
2-7	723/07	2X16AWG	TH-113	AA (A)	P8	A	PSC2 (A)	/	V					
2-7	723/07	2X16AWG	TH-116	AA (A)	P8	E	PSC2 (A)	/	Z					
2-7	723/07	3X16AWG	TH-121	AA (A)	P6	I	PSC2 (A)	/	k					
2-7	723/07	3X16AWG	TH-124	AA (A)	P6	J	PSC2 (A)	/	r					
2-7	723/07	3X16AWG	TH-95	AA (A)	P5	J	PSC2 (A)	/	A					
2-7	724/07	2/0AWG	NB61	BG (A)	TBN1	1	BB (A)	TBN	8	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	724/07	2/0AWG	NB62	BG (A)	TBN2	1	BB (A)	TBN	6					
2-7	724/07	2/0AWG	PB1	BG (A)	TBP1	1	BE (A)	/	/					
2-7	724/07	2/0AWG	PB2	BG (A)	TBP2	1	BE (A)	/	/					
2-7	726/07	1AWG	G35	MH (A)	/	1	MS (A)	SHOP PLUG	/	13	5-3.67	B6	HIGH VOLTAGE GROUND PLATE	
2-7	726/07	262MCM	G8	MH (A)	/	8	MX1 (A)	/	Q4					
2-7	726/07	6AWG	R11	MH (A)	/	2	HC (A)	V1	B					
2-7	726/07	10AWG	R13	MH (A)	/	4	FA (A)	A1.16	B					
2-7	726/07	2AWG	R14	MH (A)	/	5	BE (A)	/	/					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
RACEWAY LOCATION: "A" BODY SECTION UNDERFRAME		REV. 00 Page 11 of 11

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-7	728/07	16AWG	41CB-3	BG (A)	TB4	6	KQ (A)	TB7	4	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	728/07	16AWG	45EA-2	BG (A)	TB4	7	KQ (A)	TB3	7					
2-7	728/07	16AWG	56AD-3	BG (A)	TB6	4	KQ (A)	TB5	19	47A	5-3.181	(AB)(5-6)	AUXILIARY BOX	SEE SH. 47 (PAGE 5-3.179 OR VEHICLES # 1400, 1401, 1403, 1449)
2-7	728/07	16AWG	56AD-8	BG (A)	TB6	8	KQ (A)	TB5	16					
2-7	728/07	6AWG	C15-1	BG (A)	TB3	2	BD (A)	TBCAB	1	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	728/07	12AWG	NB34	KB (A)	NB AUX.	21	FA (A)	A1.15	B	12C	5-3.63	B(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	728/07	6AWG	NB52	BG (A)	TBN1	5	KB (A)	TB11	1÷8	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	728/07	2/0AWG	NB53	BG (A)	TBN1	2	KB (A)	NB AUX.	1	10				
2-7	728/07	6AWG	NB56-3	BG (A)	TB5	11	MT-A (A)	PTA	D	10				
2-7	728/07	6AWG	NB59	BG (A)	TBN2	3	KB (A)	TB8	4	10				
2-7	728/07	6AWG	PB56	BG (A)	TB5	10	MT-A (A)	PTA	A	10				
2-7	728/07	2AWG	S1	BG (A)	F3	/	KB (A)	IS	4	10				
2-7	728/07	6AWG	S3	BG (A)	F6	/	BD (A)	CB36	LINE	10				
2-7	728/07	16AWG	SPARE56	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	728/07	16AWG	SPARE57	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	728/07	16AWG	SPARE58	BG (A)	/	/	KB (A)	/	/	/	/	/	/	
2-7	728/07	2AWG	X1-1	BG (A)	TB3	1	KB (A)	IS	5	10	5-3.53	(ABCD)(5-6)	AUXILIARY BOX	
2-7	728/07	12AWG	X34-2	KB (A)	TB9	13	FA (A)	A1.15	A	12C	5-3.63	D(5-8)	TERMINAL BOARD PANEL	SEE SH. 12A (PAGE 5-3.59 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-7	729/07	4/0AWG	T60	EY (A)	TB1	C	MX1 (A)	/	Q1	14	7-3.29	B7	ELECTRICAL T/L CONNECTION	
2-7	729/07	4/0AWG	T64	EY (A)	TB1	B	MX1 (A)	/	Q2	14				
2-7	729/07	4/0AWG	T68	EY (A)	TB1	A	MX1 (A)	/	Q3	14				



Location Illustration Code: 2-8

Figure 11-1.23 Raceway Location - "B" Body Section - Underframe

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 1 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	332/06	16AW/TH131	42FB-1	MP (B)	M1	F	KQ (B)	TB4	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AW/TH131	42KA-4	MP (B)	M1	G	KQ (B)	TB4	14					
2-8	332/06	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A4	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH49	54HA-1	FB (B)	/	1	KB (B)	TB2	17	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH63	54HA-7	MP (B)	M3	p	KQ (B)	TB9	18	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH49	54JA-1	FB (B)	/	2	KB (B)	TB2	18	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG/TH63	54JA-7	MP (B)	M3	n	KQ (B)	TB9	19	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	54XA-2	FH (B)	/	D	KR (B)	TB1	10	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	56AD-17	MP (B)	M2	b	KB (B)	TB2	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	57BA-2	FH (B)	/	A	KQ (B)	TB3	10	44A	16-3.23	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1	44A	16-3.23	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 2 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	332/06	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	80AA-1	MP (B)	M3	v	KT (B)	TB1	12	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	80DA-1	MP (B)	M3	q	KQ (B)	TB4	23					
2-8	332/06	12AWG/TH79	80HA-1	MP (B)	M3	T	KB (B)	TB3	16					
2-8	332/06	12AWG/TH79	80JA-1	MP (B)	M3	U	KB (B)	TB3	15					
2-8	332/06	16AWG	80KA-1	MP (B)	M1	u	KQ (B)	TB4	19					
2-8	332/06	16AWG	80LA-1	MP (B)	M1	r	KQ (B)	TB4	22					
2-8	332/06	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	81QB-2	FH (B)	/	B	KQ (B)	TB3	7	44A	7-3.121	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449))
2-8	332/06	16AWG	81RA-1	MP (B)	M2	Z	KQ (B)	TB5	20	44A	7-3.121	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	81SA-1	MP (B)	M1	x	KT (B)	TB1	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	81TA-1	MP (B)	M2	T	KT (B)	TB1	14					
2-8	332/06	16AWG	81UA-1	MP (B)	M2	e	KB (B)	TB1	6					
2-8	332/06	16AWG	81VA-1	MP (B)	M3	j	KT (B)	TB2	2					
2-8	332/06	16AWG	81WA-1	MP (B)	M3	h	KT (B)	TB2	1					
2-8	332/06	16AWG	84YA-1	MP (B)	M3	g	KT (B)	TB1	19					
2-8	332/06	16AWG	ET040-5	MP (B)	M2	U	KT (B)	TB1	15					
2-8	332/06	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.67 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 3 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	332/06	16AWG	ET049-23	MP (B)	M2	A	KQ (B)	TLN1	/	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	16AWG	ET057-2	MP (B)	M1	m	KB (B)	TB3	12					
2-8	332/06	16AWG	ET058-2	MP (B)	M3	S	KB (B)	TB3	11					
2-8	332/06	16AWG	ET066-4	MP (B)	M3	w	KQ (B)	TB2	20					
2-8	332/06	16AWG	NB23-6	MP (B)	M1	p	KQ (B)	TB3	3	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	2X16AWG	TH-131	MP (B)	M1	C	KQ (B)	TB4	8	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	2X16AWG	TH-49	FB (B)	/	/	KB (B)	TB2	16	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	2X16AWG	TH-63	MP (B)	/	/	KQ (B)	TB9	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	332/06	2X12AWG	TH-79	MP (B)	/	/	KB (B)	TB3	17					
2-8	332/06	16AWG	X29-4	FH (B)	/	H	KR (B)	TB1	7	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	333/06	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	333/06	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	333/06	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5					
2-8	334/05	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-8	334/05	6AWG	NB23	MP (B)	CCUN	STD	KB (B)	NB AUX.	12	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	334/05	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	334/05	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 4 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	334/05	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	334/05	6AWG	X23-2	MP (B)	CB1	TOP	KB (B)	TB8	1	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	338/04	16AWG	81JA-1	FX (B)	/	E	MP (B)	M2	d	44A	16-3.23	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	338/04	16AWG	81KA-1	FX (B)	/	C	MP (B)	M2	c					
2-8	338/04	16AWG	NB23-1	FX (B)	/	A	MP (B)	M1	n					
2-8	339/06	16AW/TH131	42FB-1	MP (B)	M1	F	KQ (B)	TB4	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AW/TH131	42KA-4	MP (B)	M1	G	KQ (B)	TB4	14					
2-8	339/06	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A4	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH49	54HA-1	FB (B)	/	1	KB (B)	TB2	17	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH63	54HA-7	MP (B)	M3	p	KQ (B)	TB9	18	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH49	54JA-1	FB (B)	/	2	KB (B)	TB2	18	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG/TH63	54JA-7	MP (B)	M3	n	KQ (B)	TB9	19	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	54XA-2	FH (B)	/	D	KR (B)	TB1	10	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 5 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	339/06	16AWG	56AD-17	MP (B)	M2	b	KB (B)	TB2	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	57BA-2	FH (B)	/	A	KQ (B)	TB3	10	44A	4-3.53	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	80AA-1	MP (B)	M3	v	KT (B)	TB1	12	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	80DA-1	MP (B)	M3	q	KQ (B)	TB4	23					
2-8	339/06	12AWG/TH79	80HA-1	MP (B)	M3	T	KB (B)	TB3	16					
2-8	339/06	12AWG/TH79	80JA-1	MP (B)	M3	U	KB (B)	TB3	15					
2-8	339/06	16AWG	80KA-1	MP (B)	M1	u	KQ (B)	TB4	19					
2-8	339/06	16AWG	80LA-1	MP (B)	M1	r	KQ (B)	TB4	22					
2-8	339/06	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	81QB-2	FH (B)	/	B	KQ (B)	TB3	7	44A	4-3.53	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	81RA-1	MP (B)	M2	Z	KQ (B)	TB5	20	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	81SA-1	MP (B)	M1	x	KT (B)	TB1	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	81TA-1	MP (B)	M2	T	KT (B)	TB1	14					
2-8	339/06	16AWG	81UA-1	MP (B)	M2	e	KB (B)	TB1	6					
2-8	339/06	16AWG	81VA-1	MP (B)	M3	j	KT (B)	TB2	2					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 6 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	339/06	16AWG	81WA-1	MP (B)	M3	h	KT (B)	TB2	1	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	84YA-1	MP (B)	M3	g	KT (B)	TB1	19					
2-8	339/06	16AWG	ET040-5	MP (B)	M2	U	KT (B)	TB1	15					
2-8	339/06	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	ET049-23	MP (B)	M2	A	KQ (B)	TLN1	/	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	16AWG	ET057-2	MP (B)	M1	m	KB (B)	TB3	12					
2-8	339/06	16AWG	ET058-2	MP (B)	M3	S	KB (B)	TB3	11					
2-8	339/06	16AWG	ET066-4	MP (B)	M3	w	KQ (B)	TB2	20					
2-8	339/06	16AWG	ET070-2	MP (B)	M2	Y	KB (B)	TB1	4					
2-8	339/06	16AWG	NB23-6	MP (B)	M1	p	KQ (B)	TB3	3	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	2X16AWG	TH-131	MP (B)	M1	C	KQ (B)	TB4	8	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	2X16AWG	TH-49	FB (B)	/	/	KB (B)	TB2	16	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	2X16AWG	TH-63	MP (B)	/	/	KQ (B)	TB9	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	339/06	2X12AWG	TH-79	MP (B)	/	/	KB (B)	TB3	17					
2-8	339/06	16AWG	X29-4	FH (B)	/	H	KR (B)	TB1	7	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/07	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	344/07	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	344/07	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 7 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	344/07	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-8	344/07	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4					
2-8	344/07	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	344/07	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	344/07	6AWG	X23-2	MP (B)	CB1	TOP	KB (B)	TB8	1	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AW/TH131	42FB-1	MP (B)	M1	F	KQ (B)	TB4	13					
2-8	344/B/07	16AW/TH131	42KA-4	MP (B)	M1	G	KQ (B)	TB4	14					
2-8	344/B/07	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A7	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG/TH49	54HA-1	FB (B)	/	1	KB (B)	TB2	17	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.51	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG/TH63	54HA-7	MP (B)	M3	p	KQ (B)	TB9	18	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG/TH49	54JA-1	FB (B)	/	2	KB (B)	TB2	18	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449))
2-8	344/B/07	16AWG/TH63	54JA-7	MP (B)	M3	n	KQ (B)	TB9	19	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	55QB-1	FV (B)	TB2	3	PSB (B)	/	D	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 8 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	344/B/07	16AWG	55QD-1	FV (B)	TB1	23	PSB (B)	/	C	46A	5-3.177	B5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	56AD-17	MP (B)	M2	b	KB (B)	TB2	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	80AA-1	MP (B)	M3	v	KT (B)	TB1	12	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	80DA-1	MP (B)	M3	q	KQ (B)	TB4	23					
2-8	344/B/07	16AWG	80EA-1	MP (B)	M3	r	KQ (B)	TB4	20					
2-8	344/B/07	12AWG/TH79	80HA-1	MP (B)	M3	T	KB (B)	TB3	16					
2-8	344/B/07	12AWG/TH79	80JA-1	MP (B)	M3	U	KB (B)	TB3	15					
2-8	344/B/07	16AWG	80KA-1	MP (B)	M1	u	KQ (B)	TB4	19					
2-8	344/B/07	16AWG	80LA-1	MP (B)	M1	r	KQ (B)	TB4	22					
2-8	344/B/07	16AWG	81EA-1	MP (B)	M3	t	KB (B)	TB2	4	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81JA-1	MP (B)	M2	d	FX (B)	/	E					
2-8	344/B/07	16AWG	81KA-1	MP (B)	M2	c	FX (B)	/	C					
2-8	344/B/07	16AWG	81NA-1	MI (B)	LB	Z	KQ (B)	TB3	4	44A	4-3.53	B3	LINE BREAKER	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9	44A	16-3.23	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81PA-1	MI (B)	LB	X	KQ (B)	TB3	5	44A	4-3.53	B3	LINE BREAKER	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 9 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	344/B/07	16AWG	81QA-1	MI (B)	LB	Y	KQ (B)	TB3	6	44A	4-3.53	B3	LINE BREAKER	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81RA-1	MP (B)	M2	Z	KQ (B)	TB5	20	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81SA-1	MP (B)	M1	x	KT (B)	TB1	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	81TA-1	MP (B)	M2	T	KT (B)	TB1	14					
2-8	344/B/07	16AWG	81UA-1	MP (B)	M2	e	KB (B)	TB1	6					
2-8	344/B/07	16AWG	81VA-1	MP (B)	M3	j	KT (B)	TB2	2					
2-8	344/B/07	16AWG	81WA-1	MP (B)	M3	h	KT (B)	TB2	1					
2-8	344/B/07	18A/84TH1	84AA-1	MP (B)	M3	C	PSB (B)	/	P	38A	4-3.43	(ABCD) 4	POWER CONTROL EQUIPMENT	
2-8	344/B/07	18A/84TH1	84BA-1	MP (B)	M3	F	PSB (B)	/	N					
2-8	344/B/07	18A/84TH1	84CA-1	MP (B)	M3	D	PSB (B)	/	M					
2-8	344/B/07	18A/84TH1	84DA-1	MP (B)	M3	E	PSB (B)	/	L					
2-8	344/B/07	18A/84TH3	84EA-1	MP (B)	M3	H	PSB (B)	/	V					
2-8	344/B/07	18A/84TH3	84FA-1	MP (B)	M3	M	PSB (B)	/	U					
2-8	344/B/07	18A/84TH3	84GA-1	MP (B)	M3	K	PSB (B)	/	T					
2-8	344/B/07	18A/84TH3	84HA-1	MP (B)	M3	L	PSB (B)	/	S					
2-8	344/B/07	4X18AWG	84TH-1	MP (B)	M3	G	PSB (B)	/	K					
2-8	344/B/07	4X18AWG	84TH-3	MP (B)	M3	N	PSB (B)	/	R					
2-8	344/B/07	16AWG	84YA-1	MP (B)	M3	g	KT (B)	TB1	19	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	ET040-5	MP (B)	M2	U	KT (B)	TB1	15					
2-8	344/B/07	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	ET049-23	MP (B)	M2	A	KQ (B)	TLN1	/	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	ET057-2	MP (B)	M1	m	KB (B)	TB3	12					
2-8	344/B/07	16AWG	ET058-2	MP (B)	M3	S	KB (B)	TB3	11					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 10 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	344/B/07	16AWG	ET066-4	MP (B)	M3	w	KQ (B)	TB2	20	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	ET070-2	MP (B)	M2	Y	KB (B)	TB1	4					
2-8	344/B/07	16AWG	NB23-1	MP (B)	M1	n	FX (B)	/	A					
2-8	344/B/07	16AWG	NB23-6	MP (B)	M1	p	KQ (B)	TB3	3					
2-8	344/B/07	2X16AWG	TH-131	MP (B)	M1	C	KQ (B)	TB4	8					
2-8	344/B/07	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449))
2-8	344/B/07	2X16AWG	TH-49	FB (B)	/	/	KB (B)	TB2	16	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	2X16AWG	TH-63	MP (B)	/	/	KQ (B)	TB9	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	2X12AWG	TH-79	MP (B)	/	/	KB (B)	TB3	17					
2-8	344/B/07	16AWG	X29-10	FG (B)	/	G	FH (B)	/	G	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	X29-12	FV (B)	TB2	19	PSB (B)	/	A	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	344/B/07	16AWG	X29-42	FG (B)	/	I	FH (B)	/	F	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AW/TH131	42FB-1	MP (B)	M1	F	KQ (B)	TB4	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AW/TH131	42KA-4	MP (B)	M1	G	KQ (B)	TB4	14					
2-8	345/06	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A7	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG/TH49	54HA-1	FB (B)	/	1	KB (B)	TB2	17	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449))

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 11 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	345/06	16AWG/TH63	54HA-7	MP (B)	M3	p	KQ (B)	TB9	18	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG/TH49	54JA-1	FB (B)	/	2	KB (B)	TB2	18	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG/TH63	54JA-7	MP (B)	M3	n	KQ (B)	TB9	19	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	54XA-2	FH (B)	/	D	KR (B)	TB1	10	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	56AD-17	MP (B)	M2	b	KB (B)	TB2	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	57BA-2	FH (B)	/	A	KQ (B)	TB3	10	44A	4-3.53	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	80AA-1	MP (B)	M3	v	KT (B)	TB1	12	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	80DA-1	MP (B)	M3	q	KQ (B)	TB4	23					
2-8	345/06	12AWG/TH79	80HA-1	MP (B)	M3	T	KB (B)	TB3	16					
2-8	345/06	12AWG/TH79	80JA-1	MP (B)	M3	U	KB (B)	TB3	15					
2-8	345/06	16AWG	80KA-1	MP (B)	M1	u	KQ (B)	TB4	19					
2-8	345/06	16AWG	80LA-1	MP (B)	M1	r	KQ (B)	TB4	22					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 12 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	345/06	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9	44A	4-3.53	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	81QB-2	FH (B)	/	B	KQ (B)	TB3	7	44A	4-3.53	B4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	81RA-1	MP (B)	M2	Z	KQ (B)	TB5	20	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	81SA-1	MP (B)	M1	x	KT (B)	TB1	13	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	81TA-1	MP (B)	M2	T	KT (B)	TB1	14	38C				
2-8	345/06	16AWG	81UA-1	MP (B)	M2	e	KB (B)	TB1	6	38C				
2-8	345/06	16AWG	81VA-1	MP (B)	M3	j	KT (B)	TB2	2	38C				
2-8	345/06	16AWG	81WA-1	MP (B)	M3	h	KT (B)	TB2	1	38C				
2-8	345/06	16AWG	84YA-1	MP (B)	M3	g	KT (B)	TB1	19	38C				
2-8	345/06	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	ET049-23	MP (B)	M2	A	KQ (B)	TLN1	/	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	16AWG	ET057-2	MP (B)	M1	m	KB (B)	TB3	12					
2-8	345/06	16AWG	ET058-2	MP (B)	M3	S	KB (B)	TB3	11					
2-8	345/06	16AWG	ET066-4	MP (B)	M3	w	KQ (B)	TB2	20					
2-8	345/06	16AWG	NB23-6	MP (B)	M1	p	KQ (B)	TB3	3	44A	4-3.53	B2	POWER CONTROL EQUIPMENT	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	2X16AWG	TH-131	MP (B)	M1	C	KQ (B)	TB4	8	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449))

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 13 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	345/06	2X16AWG	TH-49	FB (B)	/	/	KB (B)	TB2	16	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	2X16AWG	TH-63	MP (B)	/	/	KQ (B)	TB9	21	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	345/06	2X12AWG	TH-79	MP (B)	/	/	KB (B)	TB3	17					
2-8	345/06	16AWG	X29-4	FH (B)	/	H	KR (B)	TB1	7	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	346/06	262MCM	G9	MH (B)	/	8	MX2 (B)	/	Q5	13	5-3.67	B4	HIGH VOLTAGE GROUND PLATE	
2-8	347/06	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449))
2-8	347/06	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18					
2-8	347/06	16AWG	54KA-2	FB (B)	/	10	FN (B)	EPA2	b1	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	54LA-2	FB (B)	/	12	FN (B)	EPA2	a3					
2-8	347/06	16AWG	54MA-2	FB (B)	/	11	FN (B)	EPA2	a1					
2-8	347/06	16AWG	54NA-2	FB (B)	/	8	FN (B)	EPA2	b2					
2-8	347/06	16AWG	54PA-2	FB (B)	/	5	FN (B)	EPA2	a2					
2-8	347/06	16AWG	54UA-2	FB (B)	/	16	FN (B)	EPA2	b3					
2-8	347/06	16AWG	55QB-1	FV (B)	TB2	3	PSB (B)	/	D	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	55QD-1	FV (B)	TB1	23	PSB (B)	/	C	46A	5-3.177	B5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	55RB-1	FV (B)	TB2	6	PSC (B)	/	D	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	55RC-1	FG (B)	/	L	FV (B)	TB2	7	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	55RD-1	FV (B)	TB1	18	PSC (B)	/	C	46A	5-3.177	A5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 14 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	347/06	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	83AA-1	MD (B)	DP	A	MP (B)	M2	g	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-8	347/06	16AWG	83BA-1	MD (B)	DP	B	MP (B)	M2	h					
2-8	347/06	16AWG	83CA-1	MD (B)	DP	C	MP (B)	M2	j					
2-8	347/06	16AWG	83DA-1	MD (B)	DP	D	MP (B)	M2	K					
2-8	347/06	16AWG	83EA-1	MD (B)	DP	E	MP (B)	M2	m					
2-8	347/06	16AWG	83FA-1	MD (B)	DP	F	MP (B)	M2	n					
2-8	347/06	16AWG	83GA-1	MD (B)	DP	G	MP (B)	M2	p					
2-8	347/06	16AWG	83HA-1	MD (B)	DP	H	MP (B)	M2	q					
2-8	347/06	16AWG	83JA-1	MD (B)	DP	J	MP (B)	M2	r					
2-8	347/06	16AWG	83KA-1	MD (B)	DP	K	MP (B)	M2	s					
2-8	347/06	16AWG	83LA-1	MD (B)	DP	L	MP (B)	M2	t					
2-8	347/06	16AWG	83MA-1	MD (B)	DP	M	MP (B)	M2	u					
2-8	347/06	16AWG	83NA-1	MD (B)	DP	N	MP (B)	M2	v					
2-8	347/06	16AWG	83PA-1	MD (B)	DP	P	MP (B)	M2	w					
2-8	347/06	16AWG	83QA-1	MD (B)	DP	Q	MP (B)	M2	x					
2-8	347/06	16AWG	83RA-1	MD (B)	DP	R	MP (B)	M2	y					
2-8	347/06	16AWG	83SA-1	MD (B)	DP	S	MP (B)	M2	z					
2-8	347/06	16A/83TH1	83TA-1	MD (B)	DP	W	MP (B)	M2	Q					
2-8	347/06	3X16AWG	83TH-1	MD (B)	DP	Z	MP (B)	M2	X					
2-8	347/06	16A/83TH1	83UA-1	MD (B)	DP	X	MP (B)	M2	R					
2-8	347/06	16A/83TH1	83VA-1	MD (B)	DP	Y	MP (B)	M2	V					
2-8	347/06	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 15 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	347/06	16AWG	X29-12	FV (B)	TB2	19	PSB (B)	/	A	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	X29-31	FV (B)	TB1	17	PSC (B)	/	A	46A	5-3.177	B5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	347/06	16AWG	X29-8	FG (B)	/	N	FV (B)	TB2	18	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	348/04	16AWG	55KA-4	FG (B)	/	E	FH (B)	/	C					
2-8	348/04	16AWG	55RC-1	FG (B)	/	L	FV (B)	TB2	7					
2-8	348/04	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1					
2-8	348/04	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9					
2-8	348/04	16AWG	X29-10	FG (B)	/	G	FH (B)	/	G					
2-8	348/04	16AWG	X29-42	FG (B)	/	I	FH (B)	/	F					
2-8	348/04	16AWG	X29-8	FG (B)	/	N	FV (B)	TB2	18					
2-8	349/04	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A7	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	349/04	16AWG	55RB-1	FV (B)	TB2	6	PSC (B)	/	D	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	349/04	16AWG	55RD-1	FV (B)	TB1	18	PSC (B)	/	C	46A	5-3.177	A5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	349/04	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	349/04	16AWG	X29-31	FV (B)	TB1	17	PSC (B)	/	A	46A	5-3.177	A5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	350/03	6AWG	NB58-4	EYJ (B)	J2	C	MT-B (B)	PTB	D	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-8	350/03	6AWG	PB58-1	EYJ (B)	J2	B	MT-B (B)	PTB	A					
2-8	351/03	12AWG	70BA-2	EYJ (B)	J4	G	MO (B)	/	A	40	7-3.103	A4	ELECTRICAL T/L CONNECTION	
2-8	351/03	12AWG	71BA-2	EYJ (B)	J4	H	MO (B)	/	B					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 16 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	353/03	10AWG	G50	KZ (B)	/	/	MX (B)	B50	/	12C	2-3.11	C3	FARE BOX	SEE SH. 12A (PAGE 2-3.9 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	353/03	12AWG	NB15	KZ (B)	TB	-	KB (B)	NB AUX.	9					
2-8	353/03	12AWG	X15-2	KZ (B)	TB	+	KB (B)	TB9	8					
2-8	354/09	2/0AWG	R20	MP (B)	/	/	MQ (B)	/	HG	14	4-3.25	(BC)(3-6)	POWER CONTROL EQUIPMENT	
2-8	354/09	2/0AWG	R21	MP (B)	/	/	MQ (B)	/	DC-					
2-8	354/09	2/0AWG	R22	MP (B)	/	/	MQ (B)	/	DC-					
2-8	354/09	2/0AWG	R23	MP (B)	/	/	MQ (B)	/	HG					
2-8	354/09	2/0AWG	T20	MP (B)	/	/	MQ (B)	/	RDB					
2-8	354/09	2/0AWG	T21	MP (B)	/	/	MQ (B)	/	RDB					
2-8	354/09	4/0AWG	T60	MP (B)	/	/	EY (B)	TB1	C					
2-8	354/09	4/0AWG	T64	MP (B)	/	/	EY (B)	TB1	B					
2-8	354/09	4/0AWG	T68	MP (B)	/	/	EY (B)	TB1	A					
2-8	501/CRT	16AWG	50CA-2	KB (B)	TB5	21	MWB (B)	/	A	42C	5-3.161	A5	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	501/CRT	16AWG	ET048-25	KQ (B)	TLN2	/	MWB (B)	/	E					
2-8	502/CRT	16AWG	50CA-2	KB (B)	TB5	21	MWB (B)	/	A					
2-8	502/CRT	16AWG	ET048-25	KQ (B)	TLN2	/	MWB (B)	/	E					
2-8	505/CRT	16AWG	81NA-1	MI (B)	LB	Z	KQ (B)	TB3	4	44A	4-3.53	B3	LINE BREAKER	SEE SH. 44 (PAGE 4-3.51 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	505/CRT	16AWG	81PA-1	MI (B)	LB	X	KQ (B)	TB3	5					
2-8	505/CRT	16AWG	81QA-1	MI (B)	LB	Y	KQ (B)	TB3	6					
2-8	505/CRT	16A/82TH1	82AA-1	MI (B)	LB	a	MP (B)	M1	H	38A	4-3.43	(CD)3	LINE BREAKER	
2-8	505/CRT	16A/82TH1	82BA-1	MI (B)	LB	b	MP (B)	M1	K					
2-8	505/CRT	16A/82TH1	82CA-1	MI (B)	LB	c	MP (B)	M1	V					
2-8	505/CRT	16A/82TH2	82DA-1	MI (B)	LB	e	MP (B)	M1	O					
2-8	505/CRT	16A/82TH2	82EA-1	MI (B)	LB	f	MP (B)	M1	P					
2-8	505/CRT	16A/82TH2	82FA-1	MI (B)	LB	g	MP (B)	M1	Q					
2-8	505/CRT	16AWG	82GA-1	MI (B)	LB	j	MP (B)	M1	Z					
2-8	505/CRT	16AWG	82HA-1	MI (B)	LB	k	MP (B)	M1	D					
2-8	505/CRT	16AWG	82JA-1	MI (B)	LB	m	MP (B)	M1	E					
2-8	505/CRT	16AWG	82KA-1	MI (B)	LB	n	MP (B)	M1	q					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 17 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	505/CRT	16AWG	82LA-1	MI (B)	LB	p	MP (B)	M1	Y	38A	4-3.43	(CD)3	LINE BREAKER	
2-8	505/CRT	16AWG	82MA-1	MI (B)	LB	q	MP (B)	M1	X					
2-8	505/CRT	16AWG	82NA-1	MI (B)	LB	r	MP (B)	M1	W					
2-8	505/CRT	16AWG	82PA-1	MI (B)	LB	y	MP (B)	M1	e					
2-8	505/CRT	16AWG	82QA-1	MI (B)	LB	z	MP (B)	M1	d					
2-8	505/CRT	3X16AWG	82TH-1	MI (B)	LB	d	MP (B)	M1	N					
2-8	505/CRT	3X16AWG	82TH-2	MI (B)	LB	h	MP (B)	M1	R					
2-8	505/CRT	16AWG	85AA-1	MI (B)	LB	B	MP (B)	M1	k					
2-8	505/CRT	16AWG	85BA-1	MI (B)	LB	E	MP (B)	M1	b					
2-8	505/CRT	16AWG	85CA-1	MI (B)	LB	F	MP (B)	M1	a					
2-8	505/CRT	16AWG	85DA-1	MI (B)	LB	H	MP (B)	M1	h					
2-8	505/CRT	16AWG	85EA-1	MI (B)	LB	J	MP (B)	M1	t					
2-8	505/CRT	16AWG	85FA-1	MI (B)	LB	K	MP (B)	M1	s					
2-8	505/CRT	16AWG	85GA-1	MI (B)	LB	R	MP (B)	M1	w					
2-8	505/CRT	16AWG	85HA-1	MI (B)	LB	S	MP (B)	M1	z					
2-8	505/CRT	16AWG	85JA-1	MI (B)	LB	T	MP (B)	M1	g					
2-8	505/CRT	16AWG	85KA-1	MI (B)	LB	V	MP (B)	M1	B					
2-8	720/07	16AWG	50CA-3	KB (B)	TB5	15	MW (B)	/	A	42C	5-3.161	A7	TERMINAL BOARD PANEL	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG/TH49	54HA-1	FB (B)	/	1	KB (B)	TB2	17	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG/TH48	54HA-2	EYJ (B)	J5	28	KB (B)	TB2	17	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG/TH49	54JA-1	FB (B)	/	2	KB (B)	TB2	18	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG/TH48	54JA-2	EYJ (B)	J5	27	KB (B)	TB2	18	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 18 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	720/07	16AWG	55QB-1	FV (B)	TB2	3	PSB (B)	/	D	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	55QD-1	FV (B)	TB1	23	PSB (B)	/	C	46A	5-3.177	B5	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	57CA-2	FG (B)	/	A	KQ (B)	TB3	1	44A	16-3.23	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	57DA-2	EYJ (B)	J5	48	KQ (B)	TB3	2	44A	7-3.121	C5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	81NB-2	FG (B)	/	B	KQ (B)	TB3	9	44A	16-3.23	B5	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 44 (PAGE 16-3.21 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	81PB-2	EYJ (B)	J5	45	KQ (B)	TB3	8	44A	7-3.121	B5	ELECTRICAL T/L CONNECTION	SEE SH. 44 (PAGE 7-3.119 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	83AA-1	MD (B)	DP	A	MP (B)	M2	g	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-8	720/07	16AWG	83BA-1	MD (B)	DP	B	MP (B)	M2	h					
2-8	720/07	16AWG	83CA-1	MD (B)	DP	C	MP (B)	M2	j					
2-8	720/07	16AWG	83DA-1	MD (B)	DP	D	MP (B)	M2	K					
2-8	720/07	16AWG	83EA-1	MD (B)	DP	E	MP (B)	M2	m					
2-8	720/07	16AWG	83FA-1	MD (B)	DP	F	MP (B)	M2	n					
2-8	720/07	16AWG	83GA-1	MD (B)	DP	G	MP (B)	M2	p					
2-8	720/07	16AWG	83HA-1	MD (B)	DP	H	MP (B)	M2	q	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-8	720/07	16AWG	83JA-1	MD (B)	DP	J	MP (B)	M2	r					
2-8	720/07	16AWG	83KA-1	MD (B)	DP	K	MP (B)	M2	s					
2-8	720/07	16AWG	83LA-1	MD (B)	DP	L	MP (B)	M2	t					
2-8	720/07	16AWG	83MA-1	MD (B)	DP	M	MP (B)	M2	u					
2-8	720/07	16AWG	83NA-1	MD (B)	DP	N	MP (B)	M2	v					
2-8	720/07	16AWG	83PA-1	MD (B)	DP	P	MP (B)	M2	w					
2-8	720/07	16AWG	83QA-1	MD (B)	DP	Q	MP (B)	M2	x					

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 19 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	720/07	16AWG	83RA-1	MD (B)	DP	R	MP (B)	M2	y	38A	4-3.43	(AB)3	PROPULSION DIAGNOSTIC PANEL	
2-8	720/07	16AWG	83SA-1	MD (B)	DP	S	MP (B)	M2	z					
2-8	720/07	16A/83TH1	83TA-1	MD (B)	DP	W	MP (B)	M2	Q					
2-8	720/07	3X16AWG	83TH-1	MD (B)	DP	Z	MP (B)	M2	X					
2-8	720/07	16A/83TH1	83UA-1	MD (B)	DP	X	MP (B)	M2	R					
2-8	720/07	16A/83TH1	83VA-1	MD (B)	DP	Y	MP (B)	M2	V					
2-8	720/07	16AWG	ET048-26	KQ (B)	TLN2	/	MW (B)	/	E	42C	5-3.161	A5	AUXILIARY RELAY PANEL 1	SEE SH. 42B (PAGE 5-3.159 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	2X16AWG	TH-48	EYJ (B)	J5	29	KB (B)	TB2	16	46A	7-3.125	A6	ELECTRICAL T/L CONNECTION	SEE SH. 46 (PAGE 7-3.123 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	2X16AWG	TH-49	FB (B)	/	/	KB (B)	TB2	16	46A	16-3.27	A5	BRAKE CONTROL UNIT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	X29-10	FG (B)	/	G	FH (B)	/	G	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	X29-12	FV (B)	TB2	19	PSB (B)	/	A	46A	5-3.177	A3	TERMINAL BOARD PANEL	SEE SH. 46 (PAGE 5-3.175 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	720/07	16AWG	X29-42	FG (B)	/	I	FH (B)	/	F	46A	16-3.27	C4	AUXILIARY PNEUMATIC EQUIPMENT	SEE SH. 46 (PAGE 16-3.25 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	721/07	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	721/07	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	721/07	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1					
2-8	721/07	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-8	721/07	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-8	721/07	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	

Breda Costruzioni Ferroviarie	LRV2 RACEWAY & WIRING IDENTIFICATION VEHICLE # 1400 THROUGH 1476	SAN FRANCISCO MUNI
	RACEWAY LOCATION: "B" BODY SECTION UNDERFRAME	REV. 00 Page 20 of 20

RACEWAY		CABLE TYPE	WIRE ID.	FROM EQUIPMENT			TO EQUIPMENT			REFERENCES TO IWD				NOTES
L.I. CODE	ID			DEVICE	TERM. BOARD	PIN	DEVICE	TERM. BOARD	PIN	IWD SHEET	PAGE #	EQUIP. LOC	EQUIPMENT / SUB ASSEMBLY	
2-8	721/07	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	722/07	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1					
2-8	722/07	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	722/07	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1					
2-8	722/07	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-8	722/07	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-8	722/07	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	722/07	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	722/07	6AWG	X23-2	MP (B)	CB1	TOP	KB (B)	TB8	1	38C	4-3.47	(ABC)3	POWER CONTROL EQUIPMENT	SEE SH. 38B (PAGE 4-3.45 FOR VEHICLES # 1400, 1401, 1403, 1449)
2-8	725/07	6AWG	C16-2	EYJ (B)	J1	B	BD (B)	TBCAB	1	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	
2-8	725/07	6AWG	NB50-1	EYJ (B)	J1	D	KB (B)	TB11	1	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	725/07	2/0AWG	NB51-1	EY (B)	TB2	A	KB (B)	NB AUX.	1					
2-8	725/07	6AWG	NB60-1	EYJ (B)	J2	D	KB (B)	TB8	4	10	7-3.21	A4	ELECTRICAL T/L CONNECTION	
2-8	725/07	2AWG	S2-1	EYJ (B)	J1	C	KB (B)	IS	4	10	7-3.21	C4	ELECTRICAL T/L CONNECTION	
2-8	725/07	6AWG	S4-1	EYJ (B)	J2	A	BD (B)	CB36	LINE	10	7-3.21	B4	ELECTRICAL T/L CONNECTION	
2-8	725/07	2AWG	X2-2	EYJ (B)	J1	A	KB (B)	IS	5	10	7-3.21	D4	ELECTRICAL T/L CONNECTION	

11-1.15 Integrated Wiring Table (IWT)

The Integrated Wiring Tables complement the IWD circuits representation with specific wire(s) information/data for Fault(s) troubleshooting and Maintenance activities on (previously identified) faulty Equipment.
The applicable COMMUNICATIONS SYSTEM Integrated Wiring Tables are provided in Section 11-3, para 11-3.5.
The IWT Tables provide, for each Equipment listed, the following information/data in alphanumerical sequence by Equipment Identification Code (E.I.C.):

- Cable Type.
- Wire Identification.
- Wire Connection.
- Pin Identification.
- Raceway Identification and Location.

In addition, for each Equipment, the IWT Tables provide the following references to IWD Schematics Collection:

- The IWD Sheet # where the Equipment/Subassembly and its relevant connections are represented.
- The IWD Page # of this Volume where the above IWD Sheet is provided.
- The Equipment/Subassembly co-ordinates (EQUIP.LOC) on the IWD sheet where it is represented.
- The Subassembly to which the Equipment pertains.

The IWT utilizes the EIC as the starting point for manipulation within the table and is therefore very useful for troubleshooting and maintenance activities on previously identified equipment. This table along with the RWI shall be used to determine the wiring data physical relationships to the equipment in question under repair.

Otherwise the RWI Tables, (refer to para 11-1.14) where Vehicle Section/Area lists the wiring data and relationship with the Equipment, should be used.

The IWT don't include the specific wiring information data pertaining to the SIWD, ECBS and ECBCL.

In the IWT Tables the symbol ♦ indicates that corresponding Cable/Wire is not housed in raceway.

This occurs in the following cases:

- Electronic Circuit Board to Electronic Circuit Board Connections.
- Terminal Board to terminal board Connections.
- Terminal Board to Relay Connections.
- Subsystem Internal Wiring.

Refer to para 11-3.5.2 for COMMUNICATIONS applicable IWT.

For IWT Tables content and layout details refer to para 11-1.15.2.

For Location Illustration CODE (L.I. CODE) details refer to the following para 11-1.15.1.

11-1.15.1 Raceway Locations Layout and Location Illustration Codes

The Raceway Location Layout is provided on one Illustration, which represents the entire vehicle sections and area plan. Each section/area is then subdivided into eight system specific illustrations representing a specific area on the vehicle.

A universal “Location Illustration Code” (L.I. Code) is assigned to each of the 9 illustrations as follows:

L.I. CODE		VEHICLE SECTION/AREA
2-0	Raceway Location	Vehicle Section/Area Plan
2-1	Raceway Location	Roof
2-2	Raceway Location	"A" Body Section - RH Side
2-3	Raceway Location	"A" Body Section - LH Side
2-4	Raceway Location	"B" Body Section - RH Side
2-5	Raceway Location	"B" Body Section - LH Side
2-6	Raceway Location	"A" and "B" Body Sections - Art. Sect
2-7	Raceway Location	"A" Body Section - Underframe
2-8	Raceway Location	"B" Body Section - Underframe

The L.I. Code is the universal link between the Raceway Location Illustrations presented in para 11-1.14.4 (related to the whole LRV2) and the Raceway Location Illustrations applicable to the COMMUNICATIONS presented in Section 11-3 para 11-3.5.1.

The L.I. Code is universal, it doesn’t change within the volumes M 04-A through M04-P of the IWD Manual.

Refer to para 11-3.5.1 for COMMUNICATIONS Raceway Location Illustrations (Figs. 11-3.1 through 11-3.5).

Refer to para 11-1.14.4 for whole LRV2 Raceway Location Illustrations (Figs 11-1.15 through 11-1.23).

11-1.15.2 Integrated Wiring Tables – Format Content and Layout

Figure 11-1.24 shows the Integrated Wiring Table format layout.

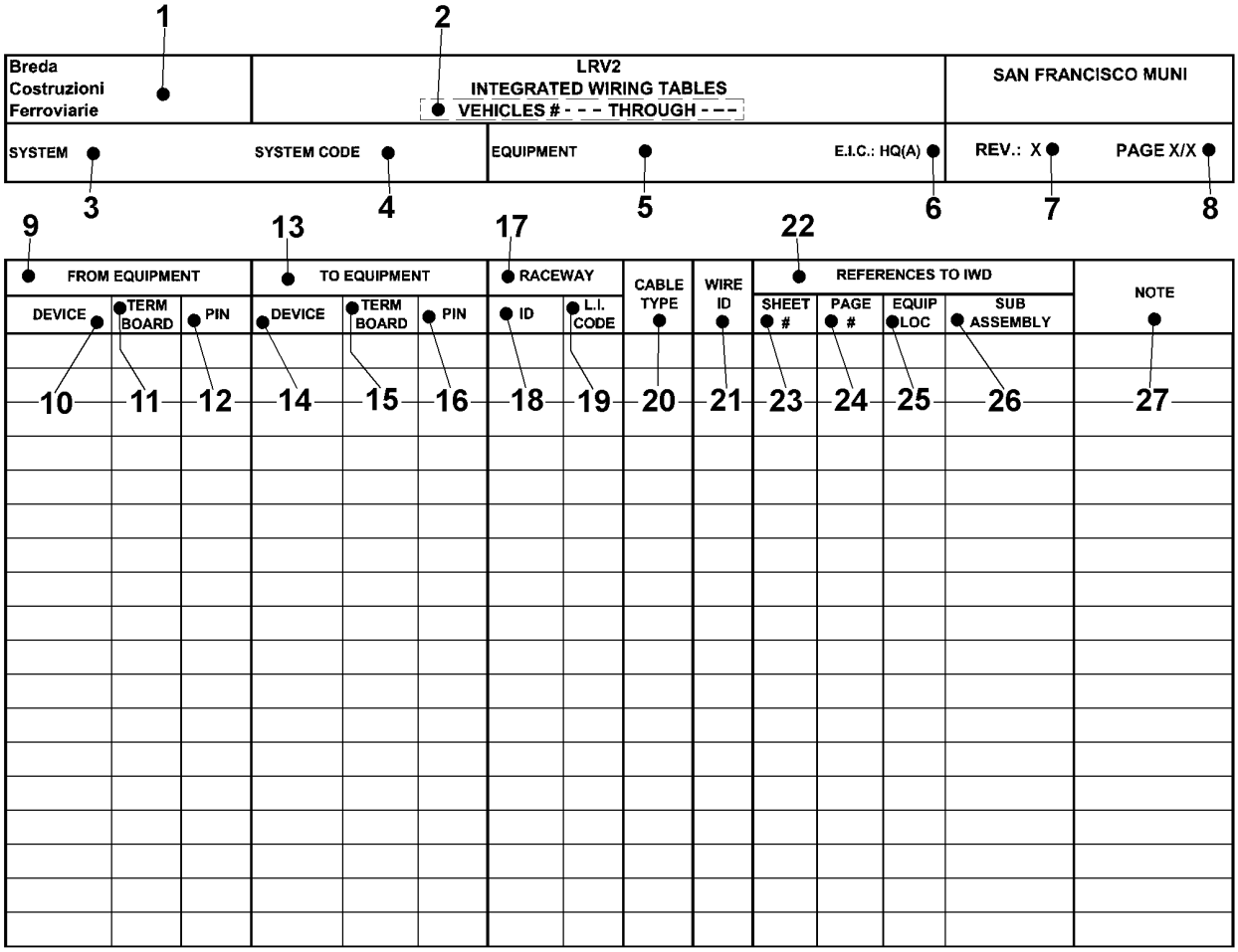


Figure 11-1.24 Integrated Wiring Table – Format

The Integrated Wiring Tables and corresponding field numbers are described as follows:

Field Number/Title	Description
1) Breda Costruzioni Ferroviarie	Name of the LVR2.
2) VEHICLE # - THROUGH #	Indicates the Vehicle # Range within the IWT Tables are applicable.
3) SYSTEM	Indicates the System to which the data listed in the IWT Table pertain.
4) SYSTEM CODE	Indicates the Code assigned to each system. Refer to para 11-1.3.1 for Codes list.
5) EQUIPMENT	Indicates the Equipment / Assy (listed in Table 11-3.1) to which the data listed in the IWT Table pertain. This field is the link with the above Table which provides SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARD DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (For Details refer to para 11-1.21).
6) E.I.C.	It is the abbreviation of Equipment Identification Code. Refer to Table 11-1.2 for complete list of the Equipment covered in the IWT Tables. The letters “A” or “B” indicate Car body reference.
7) REV #	Indicate the Revisions # of the IWT Tables.
8) PAGE X of XX	It this field it is indicated the current page (X) and the total amount of pages (XX) of the IWT Tables pertaining to the Equipment indicated in the field # 5.
9) FROM EQUIPMENT	Consists of three columns titled DEVICE (10) TERM BOARD (11), and PIN (12) which refer to the object of the Wiring Table.
10) DEVICE	Lists the Identification Code of the Equipment/Unit FROM the Cable/Wire starting point.
11) TERM BOARD	Indicates the Identification Code of the component FROM the related Cable/Wire starting point. The symbol “/” indicates the corresponding field is left blank.
12) PIN .	Indicates the Identification Code of the PIN Terminal Board FROM the Related Wire starting point. The symbol “/” indicates that the corresponding field is left blank.

13) TO EQUIPMENT .	Consists of three columns titled; Device (14) TERM Board (15) and PIN (16). The reference points is to the Cable/Wire arrival point.
14) DEVICE.	Lists the Identification Code of the Equipment/Unit to the Cable/Wire arrival point.
15) TERM BOARD.	Indicates the Identification Code of the component inside the Unit TO the Cable/Wire arrival point. The symbol "/" indicates that the corresponding field is left blank.
16) PIN	Indicates the Identification Code of the PIN Terminal Board TO the WIRE arrival point. The symbol "/" indicates that the corresponding field is left blank.
17) RACEWAY	Consists of two columns titled ID (18) and L.I. CODE (19). They provide the Identification Code and the Raceway Location (Illustration Code) of the Cable/Wire contained in fields (21) and (22).
18) ID	Indicates the Identification Codes of the Raceways installed on the vehicle.
19) L.I. CODE	Indicates the univocal Code assigned to each Raceway Location Illustration. Refer to para 11-1.15.1 for L.I. Codes List.
20) CABLE TYPE	Presents the Identification Code of the technical characteristics of the cable in accordance with (NFPA 70 and AAR S-538) requirements. The symbol (*) indicates that the Cable is supplied directly by the Supplier listed in field # 27 NOTE.
21) WIRE ID	Indicates the Identification Code of the Wire. Refer to para 2-1.12.1 for details/clarifications.
22) REFERENCES TO IWD	This field consist of 4 columns titled SHEET # (23) PAGE # (24), EQUIP. LOC. (25) and SUBASSEMBLY (26).
23) SHEET #	Indicates the Sheet number of the IWD where the specific Equipment and its relevant connections, Cable Type and Wire Identification are represented.
24) PAGE #	Indicates the IWD Volume Page # where the IWD SHEET listed in the field (23) can be found.

25) EQUIP. LOC.	Indicates the Equipment / Assy (whose E.I.C. is listed in the field 6) co-ordinates on the IWD Sheet (listed in column 23) where it is represented. When the Equipment / Assy consists of different Subassemblies, each identified by the same E.I.C., and when they are represented in different location of the same IIWD sheet, the "EQUIP:LOC" field provides the co-ordinates of each specific Subassembly (indicated in the relevant field in the SUBASSEMBLY column).
26) SUBASSEMBLY	Indicates the Subassembly pertaining to the Equipment/Assy consistently listed in the field 5 and (in correspondence with its E.I.C) in Table 11-3.1 which provides SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARD DATA AND DIAGRAMS/ SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (For Details refer to para 11-1.21). This field, as additional link to the Table 11-3.1, permits, when applicable, to easily locate (on the Table 11-3.1) only the specific Equipment / Subassembly information and data.
27) NOTE	Provides additional information (i.e. cable type, supplier etc).

11-1.15.3 How to Use the IWT Tables

The IWT are provided by System in alphabetical order and shall be used for troubleshooting or maintenance activities after the faulty system or equipment have been identified. If the faulty equipment have not been identified use the RWI tables as described in paragraph 11-1.14.3.

Using the IWT it is possible to identify, for each Equipment:

- Cable type
- Wire Identification
- Wire Connection
- Pin Identification
- Raceway Identification and Location

To use the IWT it is suggested to proceed as follows:

1) Identify the faulty System.
2) Select the corresponding Volume of the IWD Manual (Refer to para 11-1.3.3 for Manual Arrangement).

3) Identify the faulty Equipment and the Car Body Section where it is installed (A or B).

4) Refer to Table 11-1.2 “Equipment Identification Codes and On Board Location Layout” for the list of the Equipment covered in the IWT Tables.

5) Identify the E.I.C. corresponding to the faulty Equipment.

6) Go to para 11-3.5, and refer to Table 11-3.4 COMMUNICATIONS IWT List.

7) Enter the Table with both E.I.C. previously identified and the corresponding faulty Equipment (Subassembly Column) and, in conjunction, identify the starting page # where the needed IWT can be found.

8) Go to the previous selected Page # and enter the relevant Table with the E.I.C. corresponding to the faulty Equipment.

NOTE: Pay attention! The letters “A” or “B” indicate the Car Body reference.

The IWT Table will provide, for the selected E.I.C.:

- all Raceway Identification Codes;
- all Raceway Location by means of the L.I. Code;
- all Wire Identification (FROM/TO);
- all Wire connection;
- all Pin identification.

9) Refer to “REFERENCES TO IWD” columns and, in conjunction with the previous selected E.I.C.:

   - go to the page (indicated in the relevant field of the “PAGE #” column)in order to find the corresponding IWD sheet (indicated in the relevant field of the “SHEET #” column);
   - consult the selected IWD sheet to identify the Subassembly/Equipment (indicated in the relevant E.I.C. field) by means of its co-ordinates (indicates in the relevant field of the “EQUIP. LOC” column) and by means of the alphanumerical grid provided in each Schematic/Diagram.

10) Proceed with the Diagram consultation in order find the data/information to accurately troubleshoot the faulty Equipment/Assembly/System.

11) Pay attention to the reference to:
   - SIWD, indicated by ✳ positioned near the specific Equipment to which the SIWD pertains and near the relevant NOTE containing the relevant (SIWD) Supplier File #;
   - IWT, provided, when applicable, in each Schematic diagram in a dedicated area (above the IWD Manual page #).

12) Use the Fig 11-1.25, LRV2 Systems Functional Interfaces Matrix, to quickly determine the Functional Interfaces between LRV2 Systems in order to select only the needed IWD Manual Volumes to perform COMMUNICATIONS troubleshooting.
13) Use the Table 11-3.1 “SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARD DATA AND DIAGRAMS/SCHEMATIC AN MAINTENANCE MANUAL CROSS REFERENCE” to quickly determine the relationships between each Equipment (involved in the Troubleshooting/Maintenance activities) and the IWD, SIWD, IWT, ECBS, ECBCL and P & P.D.
14) Use the Table 11-3.1 also to quickly know the relevant Para (s) of the RMSM, HRWM, and the relevant sheet of the R-PMM and H-PMM where the needed Maintenance procedures/Tasks can be found in details.

11-1.16 Integrated Wiring Diagrams (IWD)

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

- The System (specific) Integrated Wiring Diagrams (IWD) (produced by BREDA) are provided in para 11-3.3.

  The System (specific) IWD are collected and presented by Sheet # order (in numerical sequence starting from the lower to the higher Sheet #).

- The complete collection of BREDA DWG 4.00.000 SCHEMATICS is provided in Volume M 04 -Q.

11-1.17 Subsystem Internal Wiring Diagrams (SIWD)

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Manual Page # is provided.

- The Subsystem (specific) Internal Wiring Diagrams (SIWD) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.4.

  The Subsystem (specific) SIWD Diagrams identified by both BCF File # and by Supplier File #, are presented by BCF File # order (In numerical sequence starting from the lower to the higher File #).

  The Subsystem (specific) SIWD Diagrams identified only by Supplier File #, are collected immediately after those SIWDs identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

11-1.18 Equipment Circuit Board Schematics (ECBS)

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

- The Equipment Circuit Board Schematics (ECBS) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.6.

  The ECBS identified by both BCF File # and by Supplier File, are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).

  The ECBS identified only by Supplier File # are collected immediately after those ECBS identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

11-1.19 Equipment Circuit Board Components Layout (ECBCL)

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

- The Equipment Circuit Board Component Layouts (ECBCL) (produced by BREDA or by BREDA Suppliers) are provided in para 11-3.7.

  The ECBCL , identified by both BCF File # and by Supplier File, # are presented by BCF File # order (in numerical sequence starting from the lower to the higher File #).

  The ECBCL identified only by Supplier File, # are collected immediately after those ECBCL identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

11-1.20 Piping & Pneumatic Drawings (P & PD)

Each Diagram/Schematic is provided in A2 format adequately folded and inserted in its own relevant plastic envelope.

Due to the number of Diagrams/Schematics involved, to help the Maintainer for Diagram(s)/Schematic(s) “finding” and /or “putting back”, on each Diagram/Schematic and on its own relevant envelope the relevant Volume Page # is provided.

- The System Piping & Pneumatic Drawings (P & PD) are provided in para 11-3.8

  The P & PD, identified by both BCF File # and by Supplier File #, are presented by BCF file # order (in numerical sequence starting from the lower to the higher File #). The P & PD identified only by Supplier File # are collected immediately after those P & PD identified by both BCF and Supplier Files # and are presented by Supplier File # order (in numerical sequence starting from the lower to the higher File #).

10-1.21 Systems Integration

● Systems Interfaces

The LRV2 Systems Functional Interface Matrix, Figure 10-1.25, provides the functional interface between the LRV2 Systems and their relationship with the corresponding IWD volumes relevant to each Vehicle Systems (Volumes M04 A through P).

Enter the matrix on the left hand side of the page; find the column titled “Vehicle System” that is the system with the fault.

The Code column lists the vehicle systems by numerical codes. A numerical code is assigned to each vehicle system and is used consistently throughout the LRV2 Maintenance Manual collection.

The column identified as “IWD Volume Number” lists the IWD volume. Refer to para 10-1.2.2 for specific details of the IWD Manuals.

Follow the row across the page and stop at the symbol (▼), this symbol points to the related IWD Volumes of systems which interface with the system being troubleshooted e.g., Air Comfort, (M04-H) interfaces with High Voltage / Low Voltage Distribution (M04-D).

The LRV2 Systems Functional Interface Matrix (relevant to applicable Volumes M04 A through P) is useful to troubleshoot a vehicle system after the desired system is identified.

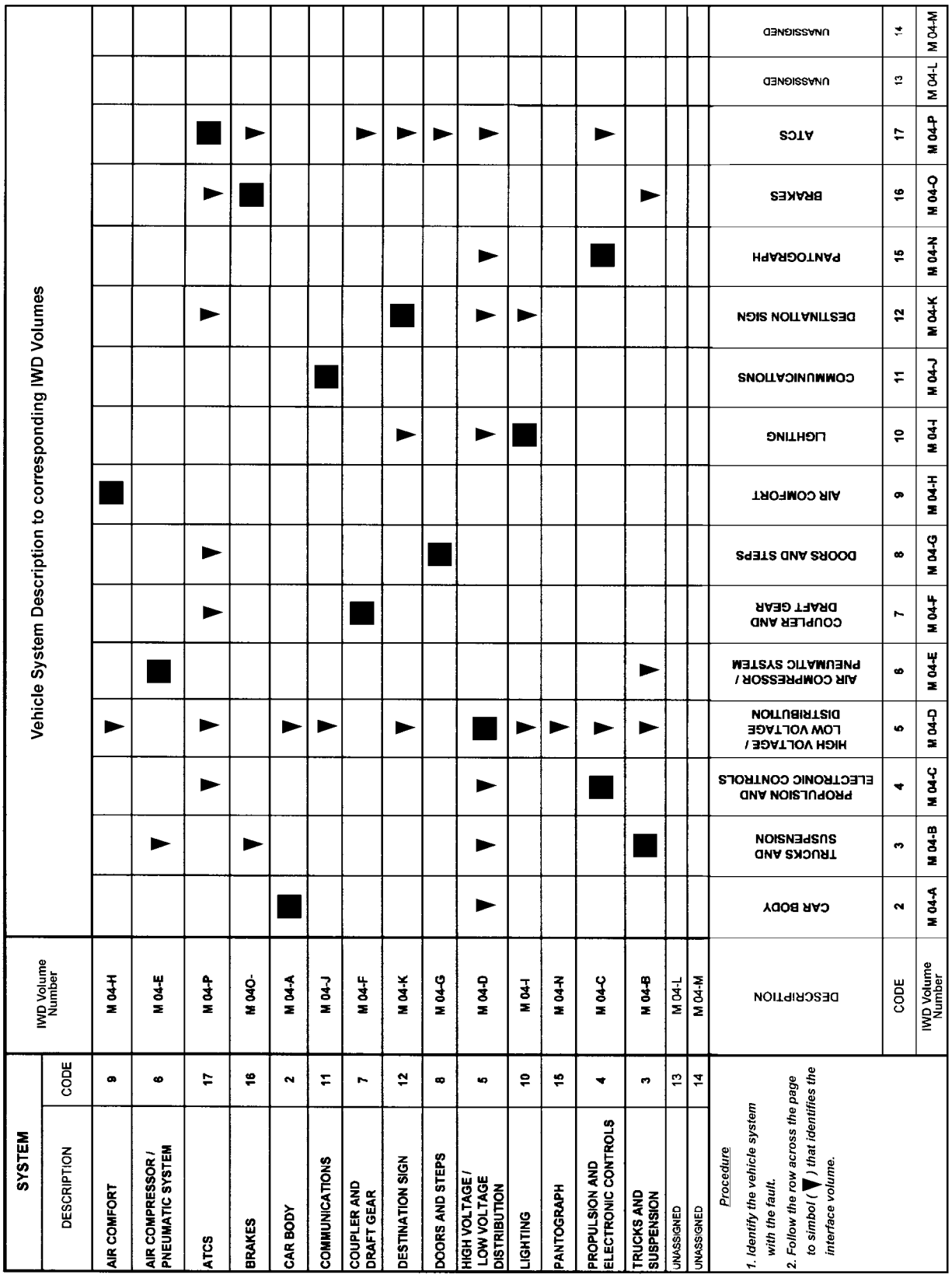

Vehicle System Description to corresponding IWD Volumes
SYSTEM
DESCRIPTION
CODE
IWD Volume Number
AIR COMFORT 9 M 04-H
AIR COMPRESSOR / PNEUMATIC SYSTEM 6 M 04-E
ATCS 17 M 04-P
BRAKES 16 M 04O-
CAR BODY 2 M 04-A
COMMUNICATIONS 11 M 04-J
COUPLER AND DRAFT GEAR 7 M 04-F
DESTINATION SIGN 12 M 04-K
DOORS AND STEPS 8 M 04-G
HIGH VOLTAGE / LOW VOLTAGE DISTRIBUTION 5 M 04-D
LIGHTING 10 M 04-I
PANTOGRAPH 15 M 04-N
PROPULSION AND ELECTRONIC CONTROLS 4 M 04-C
TRUCKS AND SUSPENSION 3 M 04-B
UNASSIGNED 13 M 04-L
UNASSIGNED 14 M 04-M
Procedure
1. Identify the vehicle system with the fault.
2. Follow the row across the page to simbol (▼) that identifies the interface volume.
CAR BODY
TRUCKS AND SUSPENSION
PROPULSION AND ELECTRONIC CONTROLS
HIGH VOLTAGE / LOW VOLTAGE DISTRIBUTION
AIR COMPRESSOR / PNEUMATIC SYSTEM
COUPLER AND DRAFT GEAR
DOORS AND STEPS
AIR COMFORT
LIGHTING
COMMUNICATIONS
DESTINATION SIGN
PANTOGRAPH
BRAKES
ATCS
UNASSIGNED
UNASSIGNED
UNASSIGNED
CODE 2 3 4 5 6 7 8 9 10 11 12 15 16 17 13 14
IWD Volume Number M 04-A M 04-B M 04-C M 04-D M 04-E M 04-F M 04-G M 04-H M 04-I M 04-J M 04-K M 04-N M 04-O M 04-P M 04-L M 04-M

Figure 11-1.25 LRV2 Systems Functional Interfaces Matrix

- **System Integrated Wirings & Circuit Boards Data and Diagrams/ Schematics and Maintenance Manuals Cross Reference**

  The following Tables 11-1.5 through 11-1.20 provide, for each Equipment/Component installed on Board, the references to the:

  - Integrated Wiring Diagrams (IWD).
  - Sub System Internal Wiring Diagrams (SIWD).
  - Integrated Wiring Tables (IWT).
  - Equipment Circuit Board Schematics (ECBS).
  - Equipment Circuit Board Component Layouts (ECBCL).
  - Piping & Pneumatic Diagrams (P & P.D).

  For completeness the Tables provide also for each Equipment/Component listed, the references to:

  - the RMSM and HRWM where the (specific Equipment) “Running” and Heavy” Maintenance Tasks are detailed.
  - the R-PM and H-PM Sheets (contained in the R-PMM and H-PMM respectively) where the (specific Equipment) “Running” and “Heavy” Preventive Maintenance are described.

  The Tables are provided in numerical sequence by System Code as indicated in the following Table 11-1.4.

Table 11-1.4 System Integrated Wiring & Circuit Boards Data and Diagrams/Schematics and Maintenance Manuals Cross Reference – Tables List

Table #	System	System Code	From Page	To Page
11-1.5	CAR BODY	02	11-1.211	11-1.211
11-1.6	TRUCK AND SUSPENSION	03	11-1.213	11-1.213
11-1.7	PROPULSION AND ELECTRONIC CONTROLS	04	11-1.215	11-1.219
11-1.8	HIGH VOLTAGE/LOW VOLTAGE DISTRIBUTION	05	11-1.221	11-1.261
11-1.9	AIR COMPRESSOR /PNEUMATIC SYSTEM	06	11-1.263	11-1.263
11-1.10	COUPLER AND DRAFT GEAR	07	11-1.265	11-1.273
11-1.11	DOORS AND STEPS	08	11-1.275	11-1.285
11-1.12	AIR COMFORT SYSTEM	09	11-1.287	11-1.287
11-1.13	LIGHTING	10	11-1.289	11-1.291
11-1.14	COMMUNICATIONS	11	11-1.293	11-1.299
11-1.15	DESTINATION SIGN	12	11-1.301	11-1.303
11-1.16	Unassigned	13	11-1.305	11-1.305
11-1.17	Unassigned	14	11-1.307	11-1.307
11-1.18	PANTOGRAPH	15	11-1.309	11-1.309
11-1.19	BRAKES	16	11-1.311	11-1.313
11-1.20	TRAIN CONTROL (ATCS)	17	11-1.315	11-1.321

In each Table the Data/References are listed in alphabetical sequence by (BREDA) Equipment Identification Code (E.I.C.). Refer to Table 11-1.2 for the list of the Equipment and their relevant E.I.C.

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TABLE 11-1.5 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE
SYSTEM:CAR BODY SYSTEM CODE: 02

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	KZ	FARE BOX	N.A.	12C	C3,C7	L.V. DISTRIBUTION AUXILIARY BUS	SEE SH. 12A (PAGE 2-3.9) FOR VEHICLES # 1400, 1401, 1403, 1449	2-3.3	2-3.11	N.A.	N.A.	N.A.	N.A.	2-3.4	--	2-3.5	2-3.21	2-3.26
	WA	WIPER MOTOR ELECTRONIC CONTROL	N.A.	42A	A3,A8	MISCELLANEOUS		2-3.3	2-3.13	N.A.	N.A.	N.A.	N.A.	2-3.4	--	2-3.5	2-3.27	2-3.32
	WE	EXTERIOR MIRROR	N.A.	42A	A5,A6	MISCELLANEOUS		2-3.3	2-3.13	N.A.	N.A.	N.A.	N.A.	2-3.4	--	2-3.5	2-3.33	2-3.38
				42D	C2,C3	MISCELLANEOUS	VALID DRAWING FOR VEHICLES # 1400, 1401, 1403, 1449 ONLY	2-3.3	2-3.15									
	WM	WASHER MOTOR PANEL	N.A.	42A	B6,B5	MISCELLANEOUS		2-3.3	2-3.13	N.A.	N.A.	N.A.	N.A.	2-3.4	--	2-3.5	2-3.39	2-3.44
	WW	WIPER MOTOR	N.A.	42A	B3,B8	MISCELLANEOUS		2-3.3	2-3.13	N.A.	N.A.	N.A.	N.A.	2-3.4	--	2-3.5	2-3.45	2-3.50

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	KZ	FARE BOX	N.A.	N.A.	N.A.	2-3.6	--	N.A.	N.A.	2-3.7	--	N.A.	N.A.	2-3.8	--	N.A.	N.A.	N.A.
	WA	WIPER MOTOR ELECTRONIC CONTROL	N.A.	N.A.	N.A.	2-3.6	N.A.	N.A.	N.A.	2-3.7	N.A.	N.A.	N.A.	2-3.8	--	2-4.3	N.A.	N.A.
	WE	EXTERIOR MIRROR	N.A.	N.A.	N.A.	2-3.6	--	N.A.	N.A.	2-3.7	--	N.A.	N.A.	2-3.8	--	2-4.4	R02-04-04-01-I R02-04-04-01-S	N.A.
	WM	WASHER MOTOR PANEL	N.A.	N.A.	N.A.	2-3.6	--	N.A.	N.A.	2-3.7	--	N.A.	N.A.	2-3.8	--	2-4.3	R02-04-03-00-S	N.A.
	WW	WIPER MOTOR	N.A.	N.A.	N.A.	2-3.6	--	N.A.	N.A.	2-3.7	--	N.A.	N.A.	2-3.8	--	2-4.3	N.A.	N.A.

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.6 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: TRUCKS AND SUSPENSION SYSTEM CODE: 03

I	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	FM	WEIGHT DETECTOR	N.A.	46A	A4, A5, A7	FRICTION BRAKE CONTROL	COMPONENT LOCATED INSIDE EQUIP. FB (B.C.U.). SEE SH. 46 (PAGE 3-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	3-3.3	3-3.19	KNORR	D5, D6, D7	4.00.230 0KB01262	MUNI ELECTRICAL INERFACE	3-3.4	3-3.25	--	--	--
										KNORR	D2	5.86.101 X1U14614	BRAKE CONTROL UNIT EP-BGE-19D &E	3-3.4	3-3.27			
	MU	GROUND BRUSH	N.A.	13	A3, A4, A5, A6	MAIN POWER WIRING DIAGRAM		3-3.3	3-3.11	N.A.	N.A.	N.A.	N.A.	3-3.4	--	--	--	--
	MW	ARTICULATION DERAIL SWITCH TRAILER TRUCK	N.A.	42C	A5	MISCELLANEOUS	SEE SH. 42B (PAGE 3-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	3-3.3	3-3.15	N.A.	N.A.	N.A.	N.A.	3-3.4	--	3-3.5	3-3.33	3-3.36
	MWA	ARTICULATION DERAIL SWITCH TRUCK "A"	N.A.	42C	A6	MISCELLANEOUS	SEE SH. 42B (PAGE 3-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	3-3.3	3-3.15	N.A.	N.A.	N.A.	N.A.	3-3.4	--	3-3.5	3-3.37	3-3.40
	MWB	ARTICULATION DERAIL SWITCH TRUCK "B"	N.A.	42C	A5	MISCELLANEOUS	SEE SH. 42B (PAGE 3-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	3-3.3	3-3.15	N.A.	N.A.	N.A.	N.A.	3-3.4	--	3-3.5	3-3.41	3-3.44

II	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS					MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	EQUIP LOC	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
	FM	WEIGHT DETECTOR	N.A.	N.A.	N.A.	3-3.6	--	N.A.	N.A.	3-3.7	--	5.00.000 SH. 1 1KB01179/1	D6, D7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	3-3.8	3-3.49	3-4.8	R03-04-08-00-T	H03-04-08-00-R
	MU	GROUND BRUSH	N.A.	N.A.	N.A.	3-3.6	--	N.A.	N.A.	3-3.7	--	N.A.	N.A.	N.A.	3-3.8	--	3-3.6	R03-03-06-00-I	H03-03-06-00-I
	MW	ARTICULATION DERAIL SWITCH TRAILER TRUCK	N.A.	N.A.	N.A.	3-3.6	--	N.A.	N.A.	3-3.7	--	N.A.	N.A.	N.A.	3-3.8	--	3-6	R03-06-00-00-I R03-06-00-00-T	--
	MWA	ARTICULATION DERAIL SWITCH TRUCK "A"	N.A.	N.A.	N.A.	3-3.6	--	N.A.	N.A.	3-3.7	--	N.A.	N.A.	N.A.	3-3.8	--	3-6	R03-06-00-00-I R03-06-00-00-T	--
	MWB	ARTICULATION DERAIL SWITCH TRUCK "B"	N.A.	N.A.	N.A.	3-3.6	--	N.A.	N.A.	3-3.7	--	N.A.	N.A.	N.A.	3-3.8	--	3-6	R03-06-00-00-I R03-06-00-00-T	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.7 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: PROPULSION AND ELECTRONIC CONTROLS SYSTEM CODE: 04

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	JB	TRUCK JUNCTION BOX	N.A.	14	A3, A(7-8)	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25	GE	E2, E5	4.00.218 SH. 6 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.83	4-3.5	4-3.189	4-3.194
	MA	TRACTION MOTOR	N.A.	14	A3, A4, A7, A8	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25	GE	C2, G2, C5, G5	4.00.218 SH. 6 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.83	4-3.5	4-3.195	4-3.200
	MD	PROPULSION DIAGNOSTIC PANEL	N.A.	38A	(AB)3	PROPULSION CONTROL		4-3.3	4-3.43	GE	FG(3-7)	4.00.218 SH. 28 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.125	4-3.5	4-3.201	4-3.204
I	ME	MASTER CONTROLLER	N.A.	11A	C1, C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 4-3.15) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.17	TCS	N.A.	4.00.228 44-3052	SCHEMATIC DIAGRAM MASTER CONTROLLER	4-3.4	4-3.177	4-3.5	4-3.205	4-3.214
				15	C(2-3), C(6-7)	AUX ON AND INTERLOCK FUNCTION WITH T/L-T/L+		4-3.3	4-3.27									
				16	C(3-5), C(5-7)	TRAIN LINE P-SIGNAL AND DIRECTION		4-3.3	4-3.29									
				26D	D2, D8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 4-3.31) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.33									
				29A	B1, C1, B8, C8	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 4-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.37									
				32A	C2, C(7-8)	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 4-3.39) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.41									
				51D	B2, B7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 4-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.61									
	MF	MAIN LINE FUSE	N.A.	13	D7	MAIN POWER WIRING DIAGRAM		4-3.3	4-3.23	GE	G7	4.00.218 SH. 1 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.73	4-3.5	4-3.215	4-3.218
	MI	LINE BREAKER	N.A.	14	C6	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25	GE	D5	4.00.218 SH. 1 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.73	4-3.5	4-3.219	4-3.222
				38A	(CD)3	PROPULSION CONTROL		4-3.3	4-3.43									
				44A	B3	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 4-3.51) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.53									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.7 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: PROPULSION AND ELECTRONIC CONTROLS SYSTEM CODE: 04 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	MJ	LINE FILTER REACTOR	N.A.	14	C5	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25	GE	D2	4.00.218 SH. 1 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.73	4-3.5	4-3.223	4-3.226
	MM	SPEED SENSORS	N.A.	38A	C6, D6, A8, B8	PROPULSION CONTROL		4-3.3	4-3.43	GE	G5, G7	4.00.218 SH. 13 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.97	--	--	--
										GE	G5, G7	4.00.218 SH. 17 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.105			
										GE	G1, G3	4.00.218 SH. 26 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.123			
	MO	PROPULSION SYSTEM MOTOR BLOWER	N.A.	40	A3	AC VOLTAGE DISTRIBUTION		4-3.3	4-3.49	--	--	--	--	--	--	4-3.5	4-3.227	4-3.230
	MP	POWER CONTROL EQUIPMENT (PCE)	N.A.	12C	C2	L.V. DISTRIBUTION AUXILIARY BUS	SEE SH. 12A (PAGE 4-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.21	GE	N.A.	4.00.218 SH 1÷57 41569668	SCHEMATIC SYSTEM	4-3.4	4-3.73	4-3.5	4-3.231	4-3.242
				14	(BC)(3-6)	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25									
				44A	B2	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 4-3.51) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.53									
				38A	(ABCD)4	PROPULSION CONTROL		4-3.3	4-3.43									
				38C	(ABC)3	PROPULSION CONTROL	SEE SH. 38B (PAGE 4-3.45) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.47									
				46A	A3	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 4-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	4-3.3	4-3.57									
	MQ	BRAKE RESISTOR	N.A.	14	D(3-6)	H.V. INTERCONNECTING WIRING DIAGRAM		4-3.3	4-3.25	GE	B(4-5)	4.00.218 SH. 2 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.75	4-3.5	4-3.243	4-3.246
										GE	B(4-5)	4.00.218 SH. 3 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.77			
	MS	KNIFE SWITCH AND AUXILIARY FUSE	N.A.	13	C7	MAIN POWER WIRING DIAGRAM		4-3.3	4-3.23	GE	CD(6-8)	4.00.218 SH. 1 41B569668	SCHEMATIC SYSTEM	4-3.4	4-3.73	4-3.5	4-3.247	4-3.250
				38A	A(7-8)	PROPULSION CONTROL		4-3.3	4-3.43									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.7 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: PROPULSION AND ELECTRONIC CONTROLS SYSTEM CODE: 04 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	JB	TRUCK JUNCTION BOX	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	--	--	--
	MA	TRACTION MOTOR	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.8	R04-02-08-00-I R04-02-08-00-S	H04-02-08-00-I H04-02-08-00-O
	MD	PROPULSION DIAGNOSTIC PANEL	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.1	R04-02-01-00-I	H04-02-01-00-I
	ME	MASTER CONTROLLER	P-SIGNAL GENERATOR BOARD	4.00.237 44-4285	SCHEMATIC P-SIGNAL GENERATOR	4-3.6	4-3.423	4-66.126 SH. 1÷4 44-1282	PRINTED WIRING ASSEMBLY P-SIG GENERATOR (A1)	4-3.7	4-3.441	N.A.	N.A.	4-3.8	--	4-3	R04-03-00-00-I	H04-03-00-00-I
			24V POWER SUPPLY BOARD	4.00.237 44-4285	SCHEMATIC P-SIGNAL GENERATOR	4-3.6	4-3.423	44-1294	PRINTED WIRING ASSEMBLY + 24V PWR SUPPLY (A2)	4-3.7	4-3.449							
	MF	MAIN LINE FUSE	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.7	R04-02-07-00-I	--
	MI	LINE BREAKER	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-3.2.6	R04-02-03-06-I	H04-02-03-00-I H04-02-03-00-O H04-02-03-00-T
	MJ	LINE FILTER REACTOR	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.5	R04-02-05-00-I	H04-02-05-00-T
	MM	SPEED SENSORS	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.8	R04-02-08-00-I	h04-02-08-00-I
	MO	PROPULSION SYSTEM MOTOR BLOWER	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.2	R04-02-02-00-C R04-02-02-00-I	H04-02-02-00-I H04-02-02-00-O H04-02-02-00-T
	MP	POWER CONTROL EQUIPMENT (PCE)	POWER SUPPLY CARD 17FB120A1	4.00.215 SH. 18 41C666172AB	SCHEMATIC R110B POWER SUPPLY	4-3.6	4-3.257	4.00.215 SH.19 41C666173JB	ASSEMBLY REFERENCE 17FB120A1 CARD	4-3.7	4-3.427	N.A.	N.A.	4-3.8	--	4-2.1.1.1	R04-02-01-00-C R04-02-01-00-I	H04-02-01-00-T
			SYSTEM ANALOG I/O CARD 17FB122B2	4.00.215 SH. 25-40 41C666205AD	SCHEMATIC SYSTEM ANALOG I/O CARD	4-3.6	4-3.259	4.00.215 SH. 41 41C666206JD	ASSEMBLY REFERENCE 17FB122B1 CARD	4-3.7	4-3.429					4-2.1.1.5		
			SYSTEM DIGITAL I/O CARD 17FB125A1	4.00.215 SH. 42-56 41C666286AE	SCHEMATIC SYSTEM DIGITAL I/O CARD	4-3.6	4-3.291	4.00.215 SH 57 41C666287JC	ASSEMBLY REFERENCE 17FB125A1 CARD	4-3.7	4-3.431					4-2.1.1.4		
			CUSTOM I/O CARD 17FB128A2	4.00.215 SH. 58-67 41C666316AA	SCHEMATIC MBTA CUSTOM I/O CARD	4-3.6	4-3.321	4.00.215 SH 68 41C666317JA	ASSEMBLY REFERENCE 17FB128A1 CARD	4-3.7	4-3.433					4-2.1.1.6		
			SYSTEM CUSTOM I/O CARD 17FB131A1	4.00.215 SH. 72-79 41C666352AA	SCHEMATIC SF-LRV CUSTOM I/O CARD	4-3.6	4-3.341	4.00.215 SH 80 41C666353JB	ASSEMBLY REFERENCE 17FB131A1 CARD	4-3.7	4-3.435					4-2.1.1.3		
			INVERTER I/O CARD 17FB134A1	4.00.215 SH. 87-100 41C666396AB	SCHEMATIC INVERTER I/O BOARD	4-3.6	4-3.357	4.00.215 SH 101 41C666397JC	ASSEMBLY REFERENCE 17FB134A1 CARD	4-3.7	4-3.437					4-2.1.1.9		
			CPU CARD 17FB136A1	4.00.215 SH. 102-116 41C666402AA	SCHEMATIC 80960KB CPU BOARD	4-3.6	4-3.385	--	--	--	--					4-2.1.1.7		
			SPEED SENSOR INTERFACE CARD 17FB146A1	4.00.215 SH. 117-120 41C666548AA	SCHEMATIC SPEED SENSOR INTERFACE CARD	4-3.6	4-3.415	4.00.215 SH 121 41C666549JA	ASSEMBLY REFERENCE 17FB146A1 CARD	4-3.7	4-3.439							
	MQ	BRAKE RESISTOR	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.4	R04-02-04-00-C R04-02-04-00-I	H04-02-04-00-T
	MS	KNIFE SWITCH AND AUXILIARY FUSE	N.A.	N.A.	N.A.	4-3.6	--	N.A.	N.A.	4-3.7	--	N.A.	N.A.	4-3.8	--	4-2.6	R04-02-06-00-I R04-02-06-00-T	H04-02-06-00-I H04-02-06-00-O H04-02-06-00-T

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION		INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
					DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	AC	OPERATOR CONSOLE	CONSOLE LIGHTS		11A	C3, C7	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 5-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.57	--	--	--	--	--	--	5-3.5	5-3.375	5-3.396
			ATCS CONTROL PANEL – DCB (DRIVER'S CONTROL BOX)		51D	B2, C7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197	ALCATEL	C3, E3	4.00.214 SH. 1 3 CU 10000	VOBC/LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.221			
					51E	(DF)1, (CF)8	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 5-3.193) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.199	ALCATEL	(DH)(8-9), (DH)(1-2)	4.00.214 SH. 14 3 CU 10000	VOBC/LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.687			
					51F	D4, D5	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 5-3.195 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.201	--	--	--	--	--	--			
			DOUBLE AIR PRESSURE GAUGE		42C	D3, D6	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	KNORR	C3	4.00.230 0KB01262	MUNI ELECTRICAL INTERFACE	5-3.4	5-3.689			
											BREDA	C3	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
			DRIVER DISPLAY UNIT (ATCS DISPLAY)		42C	D4, D5	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	BREDA	D4	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
			SPEEDOMETER		42C	D1, D8	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	BREDA	C1, C4	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
			ANNUNCIATOR PANEL	DOOR CLOSED INDICATOR	21F	B8, B3	DOOR STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	C5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				STEP HIGH / LOW INDICATORS	22D	D2, D7	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	D7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				AUX. POWER SUPPLY FAULT INDICATOR	25A	C8, D1	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	BREDA	C6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				TURN LIGHTS INDICATORS	27D	C1, C8,	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	D5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				EMER. BRAKE INDICATOR	29A	A3, A8	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	BREDA	C7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				PASSENG. EMER. STOP INDICATOR	32A	A3, A8	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	D6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				EMERG. DOOR RELEASE INDICATOR	32A	A3, A8	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	D6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				DOOR INTLK BYPASS INDICATOR	32A	A3, A8	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	C6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				REGEN BRK CUTOUT INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	D7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				OVERSPEED INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	D6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				CUTOUT BYPASS STATUS INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	C6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				PROPULSION FAULT INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	C5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				PROPULSION STALL INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	C5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				DERAIL WARNING INDICATOR	42C	A3, A8	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	BREDA	C7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION		INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
					DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	AC (Cont'd)	OPERATOR CONSOLE (Cont'd)	ANNUNCIATOR PANEL (Cont'd)	PASS. STOP REQUEST INDICATOR	43A	D1, D8	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167	BREDA	D6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693	5-3.5	5-3.375	5-3.396
				FRICTION BRAKE ON INDICATOR	46A	C1, C8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	D5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				BRAKE FAULT INDICATOR	46A	C1, C8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	D5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				BRAKE DRAGGING INDICATOR	46A	C1, C8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				LOW AIR PRESSURE INDICATOR	46A	C1, C8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				TRACK BRAKE ON INDICATOR	47A	C1, C8	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	BREDA	C5	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				ATCS CUTOUT INDICATOR	51D	B3, B6	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197	ALCATEL	E5, E7	4.00.214 SH. 12 3 CU 10000	VOBC/LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.695			
											BREDA	C6	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				MAIN POWER LOSS INDICATOR	--	--	--	--	--	--	BREDA	D7	4.00.770/775	"A"/"B" CONSOLE UPPER PANEL WIR. DIAGRAMS	5-3.4	5-3.691/5-3.693			
				ANNUNCIATOR PANEL INTERFACE	33	N.A.	ANNUNCIATION PANEL INTERFACE BOARDS	--	5-3.3	5-3.143	--	--	--	--	--	--			
					50A	(CD)(1-8)	CAB AND EXTERIOR LIGHT INDICATION "A" CAR	--	5-3.3	5-3.187									
					50B	(CD)(1-8)	CAB AND EXTERIOR LIGHT INDICATION "B" CAR	--	5-3.3	5-3.189									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	AC (Cont'd)	OPERATOR CONSOLE (Cont'd)	EMERGENCY PUSHBUTTON	29A	D(4-5), D(5-6)	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	ALCATEL	H3, H7	4.00.214 SH. 5 3CU 10000 SH. 5	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.225	5-3.5	5-3.375	5-3.396
				51F	D3, D6	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 5-3.195 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.201	BREDA	D8	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			COMMUNICATION CONTROL PANEL AND HANDSET	31A	(ED)2, (ED)6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	--	--	--	--	5-3.4	--			
			MIRROR ADJUST SWITCH	42A	A4, A6	MISCELLANEOUS		5-3.3	5-3.157	BREDA	C8	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
				42D	C1, C4	MISCELLANEOUS		5-3.3	5-3.163									
			STEPS SWITCH	22C	B3, B6	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	C8	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			RIGHT / LEFT DOOR CONTROL PANELS	21E	C(1-2) ,C(7-8)	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	B3, B4, B5, B6, B7, B8	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			PANTOGRAPH SWITCH	41A	C2, C7	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155	BREDA	D7	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			LAMP TEST PUSHBUTTON	50A	C5	CAB AND EXTERIOR LIGHT INDICATION "A" CAR		5-3.3	5-3.187	BREDA	C7	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
				50B	C5	CAB AND EXTERIOR LIGHT INDICATION "B" CAR		5-3.3	5-3.189									
			SILENT ALARM SWITCH (UNDER CONSOLE)	31A	A7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	--	--	--	--	--				
			HORN PUSHBUTTON	42A	D2, D7	MISCELLANEOUS		5-3.3	5-3.157	BREDA	C6	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			COUPLER CONTROL PANEL	24A	D3, D6	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	ALCATEL	J3, J4	4.00.214 SH. 7 3CU 10000 SH. 7	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.229			
				29A	D(4-5), D(5-6)	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	ALCATEL	D1, D9, H1, H9	4.00.214 SH. 17 3CU 10000 SH. 17	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.245			
										BREDA	D6	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			TRACK BRAKE SWITCH	47A	D3, D7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	BREDA	D5	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			LOCAL DOOR CONTROL PUSHBUTTON	21E	C2 , C7	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	C5	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
				21G	B8, D8	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 5-3.79) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.87									
				21H	B8, D8	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 5-3.81) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.89									
				42C	D1, D8	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
			EMERGENCY LIGHT PUSHBUTTON	27D	D3, D5	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	C5	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			VETAG CONTROL PANEL	27D	D2, D6	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	--	--	--	--	5-3.4	--			
			TOW MODE PUSHBUTTON	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	D5	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	AC (Cont'd)	OPERATOR CONSOLE (Cont'd)	TRAIN ID. THUMBWHEEL SWITCH	51E	C1, (BC)8	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 5-3.193) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.199	ALCATEL	(CF)8, (CF)2	4.00.214 SH. 13 3 CU 10000	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.241	5-3.5	5-3.375	5-3.396
										VAPOR	(BD)3	4.92.310 SH. 1 28846134	BOX – CODE CONTROL	5-3.4	5-3.123			
										BREDA	D2	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
			LIGHT CONTROL PANEL	26C	D(3-4), D(5-6)	INTERIOR LIGHTING	SEE SH. 26A (PAGE 5-3.107) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.111	BREDA	D3, D4	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
				26D	D3, D7	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
				27C	D(3-4), D(5-6)	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
			CAB HEAT / WIPER - WASH CONTROL PANEL	42A	A4, A6, B4, B6, C3, C6	MISCELLANEOUS		5-3.3	5-3.157	BREDA	D2, D3, D4	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
				42C	D2, D7	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
			HANDICAPPED STOP REQUEST AND DOOR UNLOCK PANEL	42C	D3, D5	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	BREDA	B5	4.00.766/767	"A"/"B" CONSOLE LOWER PANEL WIRING DIAGRAM	5-3.4	5-3.329/5-3.331			
	BA	BATTERY BOX	N.A.	10	(CD)(6-7)	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	BREDA	(HG)(5-7)	4.00.600	BA-BB BOX WIRING DIAGRAM	5-3.4	5-3.313	--	--	--
	BB	BATTERY CIRCUIT BREAKER PANEL	N.A.	10	(CD)7	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	BREDA	(CF)(5-7)	4.00.600	BA-BB BOX WIRING DIAGRAM	5-3.4	5-3.313	5-3.5	5-3.397	5-3.400
	BD	LOW VOLTAGE CIRCUIT BREAKER PANEL	N.A.	11A	D(1-4), D(5-8)	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 5-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.57	BREDA	N.A.	4.00.780	BD-A PANEL WIRING DIAGRAM	5-3.4	5-3.337	5-3.5	5-3.401	5-3.410
				12C	D(1-4), D(5-8)	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE5-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.63	BREDA	N.A.	4.00.790	BD-B PANEL WIRING DIAGRAM	5-3.4	5-3.339			
				12D	D(1-4), D(5-8)	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 5-3.61) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.65									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	BE	LOW VOLTAGE POWER SUPPLY	N.A.	10	(AD)8	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	GE	D3	41B569659 4.00.245 SH. 1	SCHEM. DIAG. INV. POWER SYSTEM	5-3.4	5-3.257	5-3.5	5-3.411	5-3.414
				13	B6	MAIN POWER WIRING DIAGRAM		5-3.3	5-3.105									
				25A	(AC)5	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	GE	N.A.	41B569659 4.00.245 SH. 8	SCHEM. DIAG. AUX. POWER SYSTEM	5-3.4	5-3.271			
				40	(AD)8	AC VOLTAGE DISTRIBUTION		5-3.3	5-3.151									
	BG	AUXILIARY BOX (LOW VOLTAGE CONTROL BOX)	N.A.	10	(ABCD)(5-6)	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	BREDA	N.A.	4.00.625	BG BOX WIRING DIAGRAM	5-3.4	5-3.315	5-3.5	5-3.415	5-3.422
				25A	C4	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105									
				40	(BCD)(6-7)	AC VOLTAGE DISTRIBUTION		5-3.3	5-3.151									
				47A	(AB)(5-6)	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
	BJ	PORTABLE BATTERIES CONNECTIONS	N.A.	12D	C8	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12B (PAGE 5-3.61) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.65	--	--	--	--	--	--	--	--	--
	BT	BATTERY THERMOSTAT	N.A.	10	C6	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	BREDA	G6	4.00.600 4.00.600	BA-BB BOX WIRING DIAGRAM	5-3.4	5-3.313	--	--	--
	FV	TERMINAL BOARD PANEL	N.A.	43A	D4	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167	--	--	--	--	--	--	5-3.5	5-3.423	5-3.432
				46A	A3,B5,B6	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177									
	GO	GONG	N.A	11A	C1, C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 5-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.57	--	--	--	--	--	--	5-3.5	5-3.433	5-3.438
				42A	D4,D5	MISCELLANEOUS	--	5-3.3	5-3.157									
	KB	TERMINAL BOARD PANEL	N.A.	11A	B(1-5), B(5-8)	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 5-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.57	--	--	--	--	--	--	5-3.5	5-3.439	5-3.476
				12C	B(1-4), B(5-8) D(1-4) D(5-8)	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE5-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.63									
				12D	B(1-4), B(5-8) D(1-4) D(5-8)	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 5-3.61) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.65									
				15	C1,C8	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71									
				16	B1,C1,C6,C8	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73									
				21E	B3, B7, D2, D7	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83									
				24A	B3,B7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101									
				26C	C4,C5	INTERIOR LIGHTING	SEE SH. 26A (PAGE 5-3.107) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.111									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KB (Cont'd)	TERMINAL BOARD PANEL (Cont'd)	N.A.	27C	C3, D6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	--	--	--	--	--	--	5-3.5	5-3.439	5-3.476
				27D	B3,B8	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121									
				31A	E3,B3,A4	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137									
				32A	C7,B4	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141									
				38C	D1,D7,A4	PROPUPLSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149									
				41A	C6	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155									
				42A	D3,D6,B4,B6	MISCELLANEOUS		5-3.3	5-3.157									
				42C	A4,A5,A6 C1,C8	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
				43A	D4,D5	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167									
				44A	C2,D7	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171									
				46A	B2, C2, C1 D8, C7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177									
				47A	D2	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
				51D	C2,C7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197									
				51E	C2, F6, C8	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 5-3.193) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.199									
	KD	HV FUSES PANEL	N.A.	13	D(5-7)	MAIN POWER WIRING DIAGRAM		5-3.3	5-3.105	BREDA	N.A.	4.00.680	KD BOX WIRING DIAGRAM	5-3.4	5-3.319	5-3.5	5-3.477	5-3.480
	KH	TRAINLINE JUNCTION BOX	N.A.	24A	B1, B4, B5 B8, D2, D7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	BREDA	N.A.	4.00.665	KH BOX WIRING DIAGRAM	5-3.4	5-3.317	5-3.5	5-3.481	5-3.504
				15	D1,D8	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KH (Cont'd)	TRAINLINE JUNCTION BOX (Cont'd)	N.A.	16	D1, D8	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	N.A.	4.00.665	KH BOX WIRING DIAGRAM	5-3.4	5-3.317	5-3.5	5-3.481	5-3.504
				21E	D1,D8,A3,A8	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83									
				21F	D1,D8	DOOR STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85									
				22C	D1,D8,C1,C8	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95									
				22D	B1,B8,D1,D8	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97									
				25A	D1, D8	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105									
				26D	D1,D8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
				27C	D1,D8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
				27D	D1,D8	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121									
				29A	D1,D8	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129									
				30A	D1,D8	CAB TO CAB INTERCOM RESET	SEE SH. 30 (PAGE 5-3.131) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.133									
				31A	H1,H8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137									
				32A	D1,D8	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141									
				35	D1,D8	DESTINATION SIGN CONTROL		5-3.3	5-3.71									
				38C	D1,D8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149									
				41A	D1,D8	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155									
				42C	A3,A8	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
				43A	D1,D8	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167									
				44A	D1, D8	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KH (Cont'd)	TRAINLINE JUNCTION BOX (Cont'd)	N.A.	46A	D1, D8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	N.A.	4.00.665	KH BOX WIRING DIAGRAM	5-3.4	5-3.317	5-3.5	5-3.481	5-3.504
				47A	D1,D8	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
				48A	H1, H8	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 5-3.183) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.185									
				51D	D1, D8	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197									
				51G	D1,D6	ATCS INTERCONNECTING WIRING TRAINLINES		5-3.3	5-3.203									
	KM	AUXILIARY ON SWITCH	N.A.	12D	C2, C6	L.V. DISTRIBUTION SYSTEM. BUS	SEE SH. 12B (PAGE 5-3.61) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.65	--	--	--	--	--	--	5-3.5	5-3.505	5-3.510
				15	C4,C5	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71									
	KO	CONVENIENCE OUTLETS	N.A.	40	D4, D2	AC VOLTAGE DISTRIBUTION		5-3.3	5-3.151	--	--	--	--	--	--	5-3.5	5-3.511	5-3.516
	KQ (A/B)	AUXILIARY RELAY PANELS 1	ER - END TRAIN RELAY (CAR A/B)	16	A7, B3, B4, B6	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	G7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
				21F	B3, C7	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	G7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				22D	C2, C7	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	ALCATEL	H3, H8	4.00.214 SH. 2 3CU 10000 SH. 2	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.223			
				24A	C2, C4, C6, C7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	ALCATEL	A1, A5, J1, J5	4.00.214 SH. 7 3CU 10000 SH. 7	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.229			
				27C	C3, C7	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	ALCATEL	H1, H7	4.00.214 SH. 9 3CU 10000 SH. 9	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.233			
				29A	A3, A4, A7	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.73	ALCATEL	G2, G9	4.00.214 SH. 18 3CU 10000 SH. 18	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.247			
				32A	A3, A7	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	--	--	--	--	--	--			
				47A	B2, B7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	--	--	--	--	--	--			
			NBR – DUAL COIL LATCH HEAD LIGHT RELAY (CAR A)	26D	C7	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113	BREDA	A7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				27C	C6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
			RAS - TURN LIGHT FLASHING RELAY (CAR A)	27D	B5, B6	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	D4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RAX - AUX. ON CONTROL RELAY (CAR A/B)	15	B4, B5	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	D6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				38C	C7	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	D4	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KQ (A/B) (Cont'd)	AUXILIARY RELAY PANELS 1 (Cont'd)	RBK - BRAKE ON INDICATION RELAY (CAR A/B)	16	B3, B5	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	D3	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
				27C	C4, C5	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	BREDA	C5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				46A	B2	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177									
			RCA - CAB CONTROL RELAY (CAR A/B)	15	B2, B4, B5, B7	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	E4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				31A	F7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	BREDA	E3	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RCAB - DOORS AND STEPS CONTROL RELAY (CAR A/B)	15	B3, B6	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	G7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				21F	B3, B7	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	G7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				22D	C1, C6	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	ALCATEL	G7, G9	4.00.214 SH. 6 3CU 10000 SH. 6	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.227			
				29A	A7, B4	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	ALCATEL	J2, J6	4.00.214 SH. 9 3CU 10000 SH. 9	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.233			
				32A	A5, A6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141									
			RCB - CAB CONTROL RELAY (CAR A/B)	15	B2, B7	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	E4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				31A	F3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	BREDA	D7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				38C	C1, C7	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149									
				42C	B4, B5	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
				45	C2, C8	VETAG INTERCONNECTING		5-3.3	5-3.173									
				47A	B2, B3, B6, B7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
			RCC - INTERIOR LIGHT CONTROL RELAY (CAR A/B)	15	B3, B6	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	E3	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				26C	C3, C6	INTERIOR LIGHTING	SEE SH. 26A (PAGE 5-3.107) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.111	BREDA	D6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				26D	C3, C6, C8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
				27C	C4, C5	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
				27D	B3, B7	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWGTITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KQ (A/B) (Cont'd)	AUXILIARY RELAY PANELS 1 (Cont'd)	RCD - CAB CONTROL RELAY (CAR A/B)	15	B2, B7	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	D7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
				42A	D1, D8	MISCELLANEOUS		5-3.3	5-3.157	BREDA	D5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				42C	C2, C7	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161									
				44A	C2, C7	SANDING & DUMP	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171									
			RCE - CAB CONTROL RELAY (CAR A/B)	15	B3, B6	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	D7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				22C	A4, A5	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	D5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				27C	C3, C6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
				41A	C2, C7	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155									
				48A	F3, F6	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 5-3.183) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.185									
				50A	B6	CAB AND EXTERIOR LIGHT INDICATION "A" CAR		5-3.3	5-3.187									
				50B	B6	CAB AND EXTERIOR LIGHT INDICATION "A" CAR		5-3.3	5-3.189									
			RE1, RE2, RE3 - COUPLER CONTROL RELAIES (CAR A/B)	15	C1, C7	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	C6, C7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				24A	C2, C4, C6, C7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	BREDA	C3, C4	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				27C	C1, C4, C5, C8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119									
				42A	D1, D8	MISCELLANEOUS		5-3.3	5-3.157									
			REMA - EMERGENCY RELAY (CAR A/B)	16	B5	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	E6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				24A	C7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	BREDA	E6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				29A	A3, A5, A6	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	ALCATEL	F2	4.00.214 SH. 7 3CU 10000 SH. 7	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.229			
				47A	B4	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	ALCATEL	G1	4.00.214 SH. 17 3CU 10000 SH. 17	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.245			
			REMB - EMERGENCY RELAY (CAR B)	16	B3	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	G6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				24A	C2	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	ALCATEL	G9	4.00.214 SH. 17 3CU 10000 SH. 17	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.245			
				29A	A4, D3	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	--	--	--	--	--	--			
				44A	C3, C4	SANDING & DUMP	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171	--	--	--	--	--	--			
				47A	B3	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	--	--	--	--	--	--			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KQ (A/B) (Cont'd)	AUXILIARY RELAY PANELS 1 (Cont'd)	REV - REVERSE CONTROL RELAY (CAR A/B)	16	B4, B7	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	D6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
				27C	C1, C4, C5, C8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	BREDA	D3	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				42A	D1, D8	MISCELLANEOUS		5-3.3	5-3.157									
				45	C2, C8	VETAG INTERCONNECTING		5-3.3	5-3.173									
			RFSB - FULL SERVICE BRAKE RELAY (CAR B)	16	A3, A4	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	E4	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				32A	A3	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	ALCATEL	D6	4.00.214 SH. 9 3CU 10000 SH. 9	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.233			
			RFW - FORWARD CONTROL RELAY (CAR A/B)	16	B4, B7	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	B7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				27C	C2, C7	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	BREDA	C6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RH - HANDICAPPED STOP REQUEST RELAY (CAR A/B)	43A	C3, C6	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167	BREDA	C4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	B5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RHC - HEATER AND HVAC COMMAND RELAY (CAR A/B)	48A	F3, F6	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 5-3.183) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.185	BREDA	D5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	C6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RHL - HEAD LIGHT COMMAND RELAY (CAR A/B)	27C	C3, C4, C5, C6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	BREDA	D5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	C6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RID - INTERIOR LIGHTING COMMAND RELAY	26C	C2	INTERIOR LIGHTING	SEE SH. 26A (PAGE 5-3.107) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.111	BREDA	C7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				26D	C3	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
			RINT - CAB INTERLOCK RELAY (CAR A/B)	15	B2, B4, B7	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	E5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				16	B4, B6	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	E3	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
										ALCATEL	G1, G9	4.00.214 SH. 20 3CU 10000 SH. 20	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.251			
			RINV - AUX. INVERTER FAULT INDICATION RELAY (CAR A)	25A	C6, C7	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	BREDA	D7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RIT1 - INTERIOR LIGHTING COMMAND DELAY RELAY (CAR A)	26D	C7, C8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113	BREDA	E3	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RIT2 - CLEANER SWITCH COMMAND RELAY (CAR A)	26D	C6, C8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113	BREDA	E3	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RL - TURN LIGHT LEFT COMMAND RELAY (CAR A)	27D	B5, B7	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	E4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RLVP - LV POWER SUPPLY FAULT INDICATION RELAY (CAR A)	25A	C6, C7	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	BREDA	D7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KQ (A/B) (Cont'd)	AUXILIARY RELAY PANELS 1 (Cont'd)	RM - MTO MODE SELECTION RELAY (CAR A/B)	16	A3, A5, B4, B6	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	E6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
										BREDA	E6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
										ALCATEL	F3, F7	4.00.214 SH. 18 3CU 10000 SH. 18	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.247			
			RPD - PANTOGRAPH DOWN COMMAND RELAY (CAR A)	41A	C6, C7	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155	BREDA	D6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RPES - PASSENGER EMERGENCY STOP RELAY (CAR A/B)	32A	A4, A6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	D4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	C5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RPU - PANTOGRAPH UP COMMAND RELAY (CAR A)	41A	C6, C7	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155	BREDA	D6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RR - TURN LIGHT RIGHT COMMAND RELAY (CAR A)	27D	B5, B7	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	E5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RSL - STOP REQUEST LIGHT COMMAND RELAY (CAR A)	43A	C6, C8	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167	BREDA	C5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RSLR - STEP LEFT LIGHTING STATUS RELAY (CAR A)	22D	C6	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	C4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				26D	C6	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
			RSM , RSM1, RSM2 - SWITCH RADIO RELAIES (CAR A)	31A	F5, F6, F7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	BREDA	B5, B6, B7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
			RSN - MANUAL SANDING COMMAND RELAY (CAR B)	44A	C2	SANDING & DUMP	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171	BREDA	C7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
			DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KQ (A/B) (Cont'd)	AUXILIARY RELAY PANELS 1 (Cont'd)	RSR - STOP REQUEST COMMAND RELAY (CAR A/B)	43A	C2, C3, C4, C5, C6, C8	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167	BREDA	C6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325	5-3.5	5-3.517	5-3.566
										BREDA	C2	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RSRR - STEP RIGHT LIGHTING STATUS RELAY (CAR A)	22D	C6	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	C5	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				26D	C6	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
			RT - MANUAL TRACK BRAKE COMMAND RELAY (CAR A)	47A	B5, B7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	BREDA	D6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										ALCATEL	D3	4.00.214 SH. 8 3CU 10000 SH. 8	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.231			
			RTF - TRAIN FUNCTIONING RELAY (CAR B)	15	B1	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	E5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				21F	B3	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85									
				26D	C2	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113									
				38C	C3	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149									
			RTL - TAIL LIGHT COMMAND RELAY (CAR A/B)	27C	C3, C4, C5, C6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 5-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.119	BREDA	D4	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	C5	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RTX - TIMING AUX. ON RELAY (CAR B)	15	B3	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	D7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RWD - WARNING DERAIL RELAY (CAR A/B)	42C	A4, A6	MISCELLANEOUS	SEE SH. 42B (PAGE 5-3.159) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.161	BREDA	F6	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
										BREDA	C6	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
			RZS - ZERO SPEED RELAY (CAR A/B)	16	B4, B6	TRAIN LINE P-SIGNAL AND DIRECTION		5-3.3	5-3.73	BREDA	E7	4.00.720	KQ-A PANEL WIRING DIAGRAM	5-3.4	5-3.325			
				21F	B7	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	E7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				24A	C2, C7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	ALCATEL	F1, F9	4.00.214 SH. 17 3CU 10000 SH. 17	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.245			
				29A	C4, C6, D3	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 5-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.129	--	--	--	--	--	--			
				38C	C2, C7	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	--	--	--	--	--	--			
			RZS1 - ZERO SPEED RELAY 1 (CAR B)	38C	C2	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	C7	4.00.735	KQ-B PANEL WIRING DIAGRAM	5-3.4	5-3.327			
				47A	B3	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
			--	51D	B3,B6	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197	N.A.	N.A.	N.A.	N.A.	N.A.	--			
			--	51E	E3,E6	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 5-3.193) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.199	N.A.	N.A.	N.A.	N.A.	N.A.	--			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KR (A/B)	AUXILIARY RELAY PANELS 2	RADA – ADA SYSTEM RELAY (CAR B)	22D	C3	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	D8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323	5-3.5	5-3.567	5-3.590
				28A	B1	ADA DOOR CHIME CAR-A		5-3.3	5-3.123									
				28B	B2	ADA DOOR CHIME CAR-B		5-3.3	5-3.125									
			RCO – SWITCH CUT OUT INDICATION RELAY (CAR B)	38C	C3	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	A8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RDC - DOOR CLOSING ANNUNCIATION RELAY (CAR A)	21E	B5, B6	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	B8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				31A	D4	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137									
			RDCL - DOOR CLOSE LEFT STATUS RELAY (CAR A)	21F	B5, B6, C7	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	B5	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				43A	D5	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167									
			RDCR - DOOR CLOSE RIGHT STATUS RELAY (CAR A)	21F	B5, B6, C7	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	B6	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				43A	D5	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167									
			RDLC1 - DOOR LOCAL CONTROL RELAY (CAR A/B)	21E	B4, B5, D2, D7	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	ALCATEL	B2, B9	4.00.214 SH. 10 3CU 10000 SH. 10	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.235			
										ALCATEL	G6, G7	4.00.214 SH. 11 3CU 10000 SH. 11	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.237			
										BREDA	D6	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
										BREDA	D6	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RDLC2 - DOOR LOCAL CONTROL RELAY (CAR A/B)	21E	A3, A7, B4, B5	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	ALCATEL	B1, B9, G6	4.00.214 SH. 11 3CU 10000 SH. 11	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.237			
										BREDA	C6	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
										BREDA	C6	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KR (A/B) (Cont'd)	AUXILIARY RELAY PANELS 2 (Cont'd)	RDLL - DOOR LOCATION LEFT RELAY (CAR A/B)	21E	C3, C6	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	B5	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321	5-3.5	5-3.567	5-3.590
				22D	C3, C6	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	B5	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RDLR - DOOR LOCATION RIGHT RELAY (CAR A/B)	21E	B3, B6	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	A7	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				22D	C3, C5	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	D5	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RDS - DOOR STATUS RELAY (CAR A/B)	21F	B2, C4, C5, B8	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	ALCATEL	J2, J6	4.00.214 SH. 9 3CU 10000 SH. 9	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.233			
				22C	A3, A7	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	ALCATEL	H4	4.00.214 SH. 10 3CU 10000 SH. 10	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.235			
				27D	B4	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	D7	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				32A	A3, A7	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	D7	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RFF – FRICTION BRAKE FAULT INDICATION RELAY (CAR B)	46A	D2, D3	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KR (A/B) (Cont'd)	AUXILIARY RELAY PANELS 2 (Cont'd)	RFO – FRICTION BRAKE ON INDICATION RELAY (CAR B)	46A	D2, D3	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323	5-3.5	5-3.567	5-3.590
			RLA – LOW AIR PRESSURE INDICATION RELAY (CAR B)	32A	A4	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	B6	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
				46A	D3	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177									
			RLC - TURN LIGHT LEFT COMMAND STEPPING RELAY (CAR A)	27D	C6	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	D8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RPF – PROPULSION FAULT INDICATION RELAY (CAR B)	38C	C2, C3	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	A8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RRC - TURN LIGHT RIGHT COMMAND STEPPING RELAY (CAR A)	27D	C5, C6	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	D8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RSDR - STEP DOWN RIGHT COMMAND RELAY (CAR A/B)	21E	B3, B6	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	C8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				22C	A3, A4, A6, A7	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	B8	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RSDS - STEP DOWN STATUS RELAY (CAR A/B)	21E	B3, B6	DOOR CONTROL	SEE SH. 21A (PAGE 5-3.75) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.83	BREDA	B7	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				22C	A3, A6	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95									
				22D	C2, C8	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97									
			RSDT - STEP DOWN COMMAND TIMED RELAY (CAR A/B)	22C	A3, A4, A6, A7	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	B7	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
										BREDA	D5	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
										BREDA	C5	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RSU - STEP UP COMMAND RELAY (CAR A)	22C	A6, A7	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	A8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RSUS - STEP UP STATUS RELAY (CAR A/B)	22C	A4, A6	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	C7	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
				22D	C3, C8	STEPS STATUS	SEE SH. 22B (PAGE 5-3.93) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.97	BREDA	C7	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
				27D	B4	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121									
			RSUT - STEP UP COMMAND TIMED RELAY (CAR A)	22C	A5, A7	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	C6	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RTDD - STEP DOWN TIME DELAY RELAY (CAR A/B)	22C	A4, A6	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	C5	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
										BREDA	C5	4.00.710	KR-B PANEL WIRING DIAGRAM	5-3.4	5-3.323			
			RTDL - TURN LEFT TIME DELAY RELAY (CAR A)	27D	C6	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	C8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RTDR - TURN RIGHT TIME DELAY RELAY (CAR A)	27D	C5	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 5-3.117) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.121	BREDA	C8	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			
			RTDU - STEP UP TIME DELAY RELAY (CAR A)	22C	A5	STEPS CONTROL	SEE SH. 22A (PAGE 5-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.95	BREDA	B6	4.00.700	KR-A PANEL WIRING DIAGRAM	5-3.4	5-3.321			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D) TRAIN CONTROL (ATCS)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KT	BY PASS SWITCH PANEL (CAR A/B)	AUXILIARY ON/OFF SWITCH	15	C3, C6	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		5-3.3	5-3.71	BREDA	B7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311	5-3.5	5-3.591	5-3.604
			CAR CLEANER SWITCH	26D	D4, D6	INTERIOR LIGHTING	SEE SH. 26B (PAGE 5-3.109) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.113	BREDA	B8	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			DOOR INTLK BYPASS SWITCH	32A	A5, A6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	C6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			EMERGENCY DOOR RELEASE BYPASS SWITCH	32A	A5, A6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 5-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.141	BREDA	A7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			FRICTION BRK CUTOUT A SWITCH	46A	D4, D7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C5	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			FRICTION BRK CUTOUT B SWITCH	46A	D4, D7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			FRICTION BRK CUTOUT C SWITCH	46A	D5, D6	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	C7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			OVERSPEED AUD. CUTOUT SWITCH	38C	B5, B8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	B6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			PANTOGRAPH CUTOUT SWITCH	41A	C4, C6	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 5-3.153) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.155	BREDA	C8	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			PROPULSION CUTOUT A SWITCH	38C	B5, B8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	B6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			PROPULSION CUTOUT B SWITCH	38C	C5, C8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	B7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			RADIO SWITCH	31A	F3, F7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137	BREDA	A8	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			REGENERATIVE BRK CUTOUT SWITCH	38C	B5, B8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	B6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			SANDING CUTOUT SWITCH	44A	D3, D6	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 5-3.169) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.171	BREDA	D8	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			AUDIBLE CUTOUT SWITCH	47A	D3, D7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	BREDA	C7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			TRACK BRK CUTOUT SWITCH	47A	D4, D6	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181	BREDA	C6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			VENTILATION BLOWER SWITCH	48A	H3, H6	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 5-3.183) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.185	BREDA	B6	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
			VOBC T/L RESET SWITCH	51D	B3, B6	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197	BREDA	A7	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
										ALCATEL	H2, H7	4.00.214 SH. 19 3CU 10000 SH. 19	VOBC / LRV2 INTERFACE SCHEMATIC	5-3.4	5-3.249			
			ZERO SPEED BYPASS SWITCH	38C	C5, C8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	B8	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)
SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	KT (Cont'd)	BY PASS SWITCH PANEL (Cont'd)	AC PWR SUPPLY FAULT INDICATOR	25A	D1, C8	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	BREDA	A4	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311	5-3.5	5-3.591	5-3.604
				50A / 50B	B3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			DOOR CLOSED INDICATOR	21F	A8, A3	DOORS STATUS	SEE SH. 21B (PAGE 5-3.77) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.85	BREDA	A3	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	B3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR			5-3.187/5-3.189									
			FRICTION BRK FAULT A INDICATOR	46A	B1, B8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	A4	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A/ 50B	A3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			FRICTION BRK FAULT B INDICATOR	46A	B1, B8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	A4	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	A3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			FRICTION BRK FAULT C INDICATOR	46A	B1, B8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	A5	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	A3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			FRICTION BRK ON INDICATOR	46A	B1, B8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177	BREDA	A4	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	A3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			LVPS FAULT INDICATOR	25A	D1, C8	AUXILIARY CONTROL	SEE SH. 25 (PAGE 5-3.103) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.105	BREDA	A4	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	B3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			PROP FAULT A INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	A3	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	B3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
			PROP FAULT B INDICATOR	38C	A5, A8	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	BREDA	A3	4.00.250 / .258	KT-A /B PANEL WIRING DIAGRAM	5-3.4	5-3.309/311			
				50A / 50B	B3	CAB AND EXTERIOR LIGHT INDICATION "A" / 'B' CAR		5-3.3	5-3.187/5-3.189									
	KW	AUDIBLE ANNUNCIATION PANEL	OVERSPEED AUDIBLE	38C	B4, B6	PROPULSION CONTROL	SEE SH. 38B (PAGE 5-3.147) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.149	--	--	--	--	--	-	5-3.5	5-3.605	5-3.610
			CHIME PASS. STOP REQUEST	43A	D1, D8	STOP REQUEST	SEE SH. 43 (PAGE 5-3.165) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.167									
			TRACK BRAKE ON	47A	C1, C8	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 5-3.179) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.181									
	MH	HIGH VOLTAGE GROUND PLATE	N.A.	13	B(3-4), B6	MAIN POWER WIRING DIAGRAM		5-3.3	5-3.67	N.A.	N.A.	N.A.	N.A.	5-3.4	--	5-3.5	5-3.611	5-3.616
	MN	LIGHTNING ARRESTOR	N.A.	13	D8	MAIN POWER WIRING DIAGRAM		5-3.3	5-3.67	--	--	--	--	--	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	MX	TRUCK/CAR BODY CONNECTION	N.A.	10	C7	LOW VOLTAGE DISTRIBUTION		5-3.3	5-3.53	--	--	--	--	--	--	5-3.5	5-3.617	5-3.630
				13	A(3-6)	MAIN POWER WIRING DIAGRAM		5-3.3	5-3.67									
				14	B3, B8	H.V. INTERCONNECTING WIRING DIAGRAM		5-3.3	5-3.69									
				31A	A7, B3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 5-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.137									
				40	A7, D2, D4	AC VOLTAGE DISTRIBUTION		5-3.3	5-3.151									
				46A	A5, C3, C5, C6	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 5-3.175) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.177									
				51D	A6, B7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 5-3.191) FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.197									
				51F	A(3-8)	ATCS CHECK LOOP & TACHO INTERFACE	SEE SH. 51C (PAGE 5-3.195 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.201									
	SK	COUPLING SWITCH	N.A.	24A	D2, D7	COUPLER CONTROL	SEE SH. 24 (PAGE 5-3.99 FOR VEHICLES # 1400, 1401, 1403, 1449	5-3.3	5-3.101	BREDA	C5	4.00.665	KH BOX WIRING DIAGRAM	5-3.4	5-3.317	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	AC	OPERATOR CONSOLE	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.9	R05-02-09-00-I	--
	BA	BATTERY BOX	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.6.1	R05-02-06-01-C R05-02-06-01-I	--
	BB	BATTERY CIRCUIT BREAKER PANEL	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.6.3	R05-02-06-03-I R05-02-06-03-T	---
	BD	LOW VOLTAGE CIRCUIT BREAKER PANEL	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.8	R05-02-08-00-I	--
	BE	LOW VOLTAGE POWER SUPPLY	ANALOG I/O CARD 17FE108	4.00.215 SH. 8÷9 41C663937	SCHEMATIC ANALOG I/O CARD	5-3.6	5-3.635	4.00.215 SH. 2 41B565923DC	COMPONENT LAYOUT 41A32134963	5-3.7	5-3.685	N.A.	N.A.	5-3.8	--	5-2.1.1.5	--	--
			DATA LOGGER CARD 17FE133B1	4.00.215 SH. 10÷12 41C666098AB	SCHEMATIC DATA LOGGER CARD	5-3.6	5-3.639	4.00.215 SH. 3 41B568065JB	ASSEMBLY REFERENCE 17FE133B1 CARD	5-3.7	5-3.687	N.A	N.A	5-3.8	--	5-2.1.1.2	--	--
			DIGITAL INPUT CARD 17FE158A1	4.00.215 SH. 13÷17 41C666152AB	SCHEMATIC DIGITAL INPUT	5-3.6	5-3.645	4.00.215 SH. 4 41B568084JA	ASSEMBLY REFERENCE 17FE158 CARD	5-3.7	5-3.689	N.A	N.A	5-3.8	--	5-2.1.1.3	--	--
			80C186 CPU BOARD 17FE159B3	4.00.215 SH. 20÷24 41C666195AD	SCHEMATIC 80C186 CPU BOARD	5-3.6	5-3.655	4.00.215 SH. 5 41B568096JC	ASSEMBLY REFERENCE 17FE159 CARD	5-3.7	5-3.691	N.A	N.A	5-3.8	--	5-2.1.1.1	--	--
			SCP DIGITAL OUTPUT CARD 17FE101B1	4.00.215 SH. 69÷71 41C666345AA	SCHEMATIC SCP DIGITAL OUTPUT	5-3.6	5-3.665	4.00.215 SH. 6 41B568174JB	ASSEMBLY REFERENCE 17FB101 CARD	5-3.7	5-3.693	N.A	N.A	5-3.8	--	5-2.1.1.4	--	--
			SPECIAL AUXILIARY I/O CARD 17FE170A1	4.00.215 SH. 81÷86 41C666359AA	SCHEMATIC SPECIAL AUXILIARY I/O CARD	5-3.6	5-3.671	4.00.215 SH. 7 41B568180JB	ASSEMBLY REFERENCE 17FE170 CARD	5-3.7	5-3.695	N.A	N.A	5-3.8	--	5-2.1.1.6	--	--
	BG	AUXILIARY BOX (LOW VOLTAGE CONTROL BOX)	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	5-2.4	R05-02-04-00-C R05-02-04-00-I	--
	BJ	PORTABLE BATTERIES CONNECTIONS	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	--	--	--
	BT	BATTERY THERMOSTAT	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	5-2.6.4	--	--
	FV	TERMINAL BOARD PANEL	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	--	--	--
	GO	GONG	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	5-2.14	R05-02-14-00-I	--
	KB	TERMINAL BOARD PANEL	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	5-2.11	R05-02-11-00-C R05-02-11-00-I	--
	KD	HV FUSES PANEL	N.A	N.A	N.A	5-3.6	--	N.A	N.A	5-3.7	--	N.A	N.A	5-3.8	--	5-2.2	R05-02-02-00-C R05-02-02-00-I	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.8 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: H.V./L.V. DISTRIBUTION SYSTEM CODE: 05 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II (Cont'd)	KH	TRAINLINE JUNCTION BOX	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.7	R05-02-07-00-I	--
	KM	AUXILIARY ON SWITCH	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.5	R05-02-05-00-I	--
	KO	CONVENIENCE OUTLETS	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.15	--	--
	KQ	AUXILIARY RELAY PANELS	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.12	R05-02-12-00-C R05-02-12-00-I	--
	KR	AUXILIARY RELAY PANELS	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.13	R05-02-13-00-C R05-02-13-00-I	--
	KT	BY PASS SWITCH PANELS	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.10	R05-02-10-00-I	--
	KW	AUDIBLE ANNUNCIATION PANEL	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	--	--	--
	MH	HIGH VOLTAGE GROUND PLATE	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.3	R05-02-03-00-I	--
	MN	LIGHTNING ARRESTOR	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.1.36	--	--
	MX	TRUCK/CAR BODY CONNECTION	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	--	--	--
	SK	COUPLING SWITCH	N.A.	N.A.	N.A.	5-3.6	--	N.A.	N.A.	5-3.7	--	N.A.	N.A.	5-3.8	--	5-2.7	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.9 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: AIR COMPRESSOR/PNEUMATIC SYSTEM SYSTEM CODE: 06

				INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	FA	AIR COMPRESSOR	N.A.	12C	C5	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 6-3.15) FOR VEHICLES # 1400, 1401, 1403, 1449	6-3.3	6-3.17	KNORR	D4	4.00.230 0KB01262	MUNI ELECTRICAL INTERFACE	6-3.4	6-3.29	6-3.5	6-3.33	6-3.36
				13	B6	MAIN POWER WIRING DIAGRAM		6-3.3	6-3.19									
				46A	B7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 6-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	6-3.3	6-3.25									
	FC	BRAKE CYLINDER PRESSURE SWITCH	N.A.	46A	C8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 6-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	6-3.3	6-3.25	KNORR	D5	4.00.230 0KB01262	MUNI ELECTRICAL INTERFACE	6-3.4	6-3.29	6-3.5	6-3.37	6-3.40
	FK	MAIN RESERVOIR PRESSURE SWITCH	N.A.	N.A.	N.A.	N.A.	N.A.	6-3.3	--	N.A.	N.A.	N.A.	N.A.	6-3.4	--	--	--	--
	FT	HORN MAGNET VALVE	N.A.	11A	C1, C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 6-3.11) FOR VEHICLES # 1400, 1401, 1403, 1449	6-3.3	6-3.13	KNORR	D3	4.00.230 0KB01262	MUNI ELECTRICAL INTERFACE	6-3.4	6-3.29	6-3.5	6-3.41	6-3.46
				42A	D3, D6	MISCELLANEOUS		6-3.3	6-3.21									

				EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS					MAINTENANCE MANUALS REFERENCE		
	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	EQUIP LOC	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	FA	AIR COMPRESSOR	N.A.	N.A.	N.A	6-3.6	--	N.A	N.A	6-3.7	--	5.00.000 SH. 1 1KB01179/1 SH. 1	CD(1-2)	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	6-3.8	6-3.51	6-2.1.1	R06-02-01-01-I R06-02-01-01-S	H06-02-01-01-I
	FC	BRAKE CYLINDER PRESSURE SWITCH	N.A.	N.A.	N.A	6-3.6	--	N.A	N.A	6-3.7	--	5.00.000 SH. 1 1KB01179/1 SH. 1	D2	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	6-3.8	6-3.51	6-2.1.6	R06-02-01-06-I	H06-02-01-06-I
	FK	MAIN RESERVOIR PRESSURE SWITCH	N.A.	N.A.	N.A	6-3.6	--	N.A	N.A	6-3.7	--	5.00.000 SH. 1 1KB01179/1 SH. 1	D2	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	6-3.8	6-3.51	6-2.1.6	R06-02-01-06-I	H06-02-01-06-I
	FT	HORN MAGNET VALVE	N.A.	N.A.	N.A	6-3.6	--	N.A	N.A	6-3.7	--	5.00.000 SH. 1 1KB01179/1 SH. 1	D1, D8	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	6-3.8	6-3.51	6-3.2	R06-03-02-00-I	H06-03-02-00-I

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.10 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COUPLER SYSTEM CODE: 07

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	ET	UNCOUPLE SOLENOID VALVE CONNECTION	N.A.	24A	B3, B7	COUPLER CONTROL	SEE SH. 24 (PAGE 7-3.53) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.55	--	--	--	--	--	--	7-3.5	7-3.165	7-3.170
I	EX	ELECTRICAL COUPLER	N.A.	12C	C3, C7	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 7-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.25	DELLNER	N.A.	4.00.219 11-63827	WIRING DIAGRAM TYPE 100 COUPLER	7-3.4	7-3.151	--	--	--
			N.A.	20	N.A.	COUPLER PIN ARRANGEMENT		7-3.3	7-3.35									
			PIN 01 (T/L 1) PIN 04 (T/L 2) PIN 15 (T/L 15) PIN 102 (T/L 3) PIN 104 (T/L 4) PIN 115 (T/L 16)	21E	D1,D8, A3, A8	DOOR CONTROL	SEE SH. 21A (PAGE 7-3.37) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.41									
			PIN 24 (T/L 24) PIN 124 (T/L 25) PIN 113 (T/L 14) PIN 13 (T/L 13)	21F	D1, D8	DOOR STATUS	SEE SH. 21B (PAGE 7-3.39) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.43									
			PIN 06 (T/L 5) PIN 08 (T/L 6) PIN 106 (T/L 8) PIN 108 (T/L 7)	22C	D1, D8, C1, C8	STEPS CONTROL	SEE SH. 22A (PAGE 7-3.45) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.49									
			PIN 09 (T/L 10) PIN 12 (T/L 11) PIN 112 (T/L 12) PIN 109 (T/L 9) PIN 55-155 (T/L 101)	22D	B1, B8, D1, D8	STEPS STATUS	SEE SH. 22B (PAGE 7-3.47) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.51									
			PIN 30-130 (T/L 30) PIN 88, 187, 190, 87, 90, 189, 89, 91, 191, 188, 92, 192	24A	A(3-4), A(5-6), D1, D8	COUPLER CONTROL	SEE SH. 24 (PAGE 7-3.53) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.55									
			PIN 27-127 (T/L 27) PIN 47-147 (T/L 47)	26D	D1, D8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 7-3.63) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.67									
			PIN 18-118 (T/L 18)	27C	D1, D8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 7-3.69) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.73									
			PIN 129 (T/L 29) PIN 29 (T/L 28)	27D	D1, D8	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 7-3.71) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.75									
			PIN 36-136 (T/L 36) PIN 38-138 (T/L 38) PIN 05-105 (T/L 89) PIN 07-107 (T/L 90) PIN 110 (T/L 92) PIN 10 (T/L 91) PIN 120 (T/L 97) PIN 20 (T/L 20) PIN 16 (T/L 100) PIN 116 (T/L 99) PIN 11-111 (T/L 98)	51D	D1, D8	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 7-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.141									
			PIN 14 (T/L 93) PIN 114 (T/L 94)	51F	D1, D8	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE7-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.145									
			PIN 28-128 (T/L 96) PIN 25-125 (T/L 95)	51G	D1, D4	ATCS INTERCONNECTING WIRING TRAINLINES		7-3.3	7-3.147									
			PIN 61-161 (T/L 61) PIN 62-162 (T/L 62) PIN 72-172 (T/L 72) PIN 71-171 (T/L 71) PIN 49-149 (T/L 49) PIN 69-169 (T/L 69) PIN 48-148 (T/L 48) PIN 68-168 (T/L 68)	15	D1, D8	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		7-3.3	7-3.31									
			PIN 51-151 (T/L 51) PIN 52-152 (T/L 52) PIN 56 (T/L 55) PIN 156 (T/L 56) PIN 67-167 (T/L 67) PIN 58-158 (T/L 58) PIN 57-157 (T/L 57)	16	D1, D8	TRAIN LINE P-SIGNAL AND DIRECTION		7-3.3	7-3.33									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.10 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COUPLER SYSTEM CODE: 07 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	EX (Cont'd)	ELECTRICAL COUPLER (Cont'd)	PIN 43-143 (T/L 43)	25A	D1, D8	AUXILIARY CONTROL	SEE SH. 25 (PAGE 7-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.59	DELLNER	N.A.	4.00.219 11-63827	WIRING DIAGRAM TYPE 100 COUPLER	7-3.4	7-3.151	--	--	--
			PIN 54-154 (T/L 54) PIN 53-153 (T/L 53) PIN 03-103 (T/L 88) PIN 01-101 (T/L 87) PIN 50-150 (T/L 50) PIN 44-144 (T/L 44)	29A	D1, D8	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 7-3.79) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.81									
			PIN 65-165 (T/L 65)	30A	D1, D8	CAB TO CAB INTERCOM RESET	SEE SH. 30 (PAGE 7-3.83) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.85									
			PIN 80 (T/L 80) PIN 83-183 (T/L 83) PIN 82-182 (T/L 82) PIN 86-186 (T/L 86) PIN 81-181 (T/L 81) PIN 84-184 (T/L 84) PIN 85-185 (T/L 84)	31A	H1, H8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 7-3.87) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.89									
			PIN 74-174 (T/L 74) PIN 59-159 (T/L 59) PIN 73-173 (T/L 73) PIN 60-160 (T/L 60) PIN 46-146 (T/L 46) PIN 63-163 (T/L 63)	32A	D1, D8	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 7-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.93									
			PIN 31-131 (T/L 31) PIN 32-132 (T/L 32) PIN 17-117 (T/L 17)	35	D1, D8	DESTINATION SIGN CONTROL		7-3.3	7-3.95									
			PIN 70-170 (T/L 70) PIN 40-140 (T/L 40) PIN 66-166 (T/L 66) PIN 41-141 (T/L 41) PIN 64-164 (T/L 64) PIN 75-175 (T/L 75)	38C	D1, D8	PROPULSION CONTROL	SEE SH. 38B (PAGE 7-3.99) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.101									
			PIN 22-122 (T/L 22) PIN 23-123 (T/L 23)	41A	D1, D8	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 7-3.105) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.107									
			PIN 45-145 (T/L 45)	42C	A3, A8	MISCELLANEOUS	SEE SH. 42B (PAGE 7-3.111) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.113									
			PIN 42-142 (T/L 42)	43A	D1, D8	STOP REQUEST	SEE SH. 43 (PAGE 7-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.117									
			PIN 26-126 (T/L 26)	44A	D1, D8	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 7-3.119) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.121									
			PIN 39-139 (T/L 39) PIN 19-119 (T/L 19) PIN 35-135 (T/L 35) PIN 37-137 (T/L 37)	46A	D1, D8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 7-3.123) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.125									
			PIN 34-134 (T/L 34) PIN 33-133 (T/L 33)	47A	D1, D8	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 7-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.129									
			PIN 21-121 (T/L 21)	48A	D1, D8	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 7-3.131) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.133									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.10 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COUPLER SYSTEM CODE: 07 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	EY	ELECTRICAL T/L CONNECTION	N.A.	10	A4, B4, D4	LOW VOLTAGE DISTRIBUTION		7-3.3	7-3.21	--	--	--	--	--	--	7-3.5	7-3.171	7-3.228
				13	B5, C5	MAIN POWER WIRING DIAGRAM		7-3.3	7-3.27									
				14	C7	H.V. INTERCONNECTING WIRING DIAGRAM		7-3.3	7-3.29									
				15	A5, B5, C5, D5	AUX ON AND INTERLOCK FUNCT. WITH T/L- AND T/L+		7-3.3	7-3.31									
				16	C5, D5	TRAIN LINE P-SIGNAL AND DIRECTION		7-3.3	7-3.33									
				21E	B5, D5	DOOR CONTROL	SEE SH. 21A (PAGE 7-3.37) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.41									
				21F	A5, C5, D5	DOORS STATUS	SEE SH. 21B (PAGE 7-3.39) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.43									
				22C	A5, B5, C5, D5	STEPS CONTROL	SEE SH. 22A (PAGE 7-3.45) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.49									
				22D	A5, B5, C5, D5	STEPS STATUS	SEE SH. 22B (PAGE 7-3.47) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.51									
				24A	D5	COUPLER CONTROL	SEE SH. 24 (PAGE 7-3.53) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.55									
				25A	D3	AUXILIARY CONTROL	SEE SH. 25 (PAGE 7-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.59									
				26C	D5	INTERIOR LIGHTING	SEE SH. 26A (PAGE 7-3.61) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.65									
				26D	C5, D5	INTERIOR LIGHTING	SEE SH. 26B (PAGE 7-3.63) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.67									
				27C	D5	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 7-3.69) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.73									
				27D	D4	EXT. LIGHTING (TURN LIGHT)	SEE SH. 27B (PAGE 7-3.71) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.75									
				28A	C2	ADA DOOR CHIME CAR-A		7-3.3	7-3.77									
				29A	A5, B5, C5, D5	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 7-3.79) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.81									
				30A	D5	CAB TO CAB INTERCOM RESET	SEE SH. 30 (PAGE 7-3.83) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.85									
				31A	A4, B4, E4 G4, H4	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 7-3.87) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.89									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.10 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COUPLER SYSTEM CODE: 07 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	EY (Cont'd)	ELECTRICAL T/L CONNECTION (Cont'd)	N.A.	32A	D5, B6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 7-3.91) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.93	--	--	--	--	--	--	7-3.5	7-3.171	7-3.228
				35	D4	DESTINATION SIGN CONTROL		7-3.3	7-3.95									
				38A	A7, B7	PROPULSION CONTROL		7-3.3	7-3.97									
				38C	A6, D6	PROPULSION CONTROL	SEE SH. 38B (PAGE 7-3.99) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.101									
				40	B4, C4	AC VOLTAGE DISTRIBUTION		7-3.3	7-3.103									
				41A	C5, D5	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 7-3.105) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.107									
				42A	D5	MISCELLANEOUS		7-3.3	7-3.109									
				42C	C4, B5	MISCELLANEOUS	SEE SH. 42B (PAGE 7-3.111) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.113									
				43A	D4	STOP REQUEST	SEE SH. 43 (PAGE 7-3.115) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.117									
				44A	C5, D5	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 7-3.119) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.121									
				46A	B6, C6, D6	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 7-3.123) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.125									
				47A	C5, D5	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 7-3.127) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.129									
				48A	D5	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 7-3.131) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.133									
				51D	D4	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 7-3.135) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.141									
				51E	C3, D3, E3, G3	WIRING INTERCONNECTI0N ATCS EQUIP.	SEE SH. 51B (PAGE 7-3.137) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.143									
				51F	D5	ATCS CHECK LOOP & TACHO INTERFACES	SEE SH. 51C (PAGE 7-3.139) FOR VEHICLES # 1400, 1401, 1403, 1449	7-3.3	7-3.145									
				51G	D3	ATCS INTERCONNECTING WIRING TRAINLINES		7-3.3	7-3.147									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.10 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COUPLER SYSTEM CODE: 07 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	ET	UNCOUPLE SOLENOID VALVE CONNECTION	N.A.	N.A.	N.A.	7-3.6	--	N.A.	N.A.	7-3.7	--	N.A.	N.A.	7-3.8	--	7-2.3.6	R07-02-03-06-I	H07-02-03-06-I
	EX	ELECTRICAL COUPLER	N.A.	N.A.	N.A.	7-3.6	--	N.A.	N.A.	7-3.7	--	N.A.	N.A.	7-3.8	--	7-2.2.1 7-2.2.2	R07-02-02-01-C R07-02-02-01-I R07-02-02-02-C R07-02-02-02-I	H07-02-02-01-I H07-02-02-02-I
	EY	ELECTRICAL TRAIN LINE CONNECTION	N.A.	N.A.	N.A.	7-3.6	--	N.A.	N.A.	7-3.7	--	N.A.	N.A.	7-3.8	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	DA	OBSTRUCTION ALARM	N.A.	21G	A6, C7, C4, A5	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B6, E7	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.127	8-3.144
				21H	A6, C7, C4, A5	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	A7, E7	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B7, E7	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B7, F6	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	DF	INTERNAL PASSENGER PUSHBUTTON	N.A.	21G	A7, D7, D6, C2 C4, B4, B5	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B6, E6, E4	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.145	8-3.174
				21H	A7, D7, D6, C2 C4, B4, B5	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B4, B6, E6, E4	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B4, B6, E6, E4	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B6, B4, F6	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	DK	INTERNAL DOOR CREW SWITCH	N.A.	21G	D6, B6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	N.A.	N.A.	N.A.	N.A.	8-3.4	--	8-3.5	8-3.175	8-3.184
				21H	D6, B6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43									
	DM	EXTERNAL DOOR CREW SWITCH	N.A.	21G	C6, B6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	N.A.	N.A.	N.A.	N.A.	8-3.4	--	8-3.5	8-3.185	8-3.194
				21H	C6, B6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43									
	DN	PASSENGER EMERGENCY STOP	N.A.	32A	C4, D6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 8-3.69) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.71	N.A.	N.A.	N.A.	N.A.	8-3.4	--	8-3.5	8-3.195	8-3.200
	DO	DOOR OPERATOR	N.A.	21E	D3, D4, D5, D6 A3, A4, A5, A6	DOOR CONTROL	SEE SH. 21A (PAGE 8-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.37	VAPOR	N.A.	4.80.320 SH. 4 59304203	CONNECTION DIAGRAM FOR 59366243 OPER. ASSY DOOR	8-3.4	8-3.109	8-3.5	8-3.201	8-3.250
				21F	D3, D4, D5, D6	DOORS STATUS	SEE SH. 21B (PAGE 8-3.31) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.39	VAPOR	N.A.	4.80.310 SH. 4 59304204	CONNECTION DIAGRAM FOR 59366235 OPER. ASSY DOOR	8-3.4	8-3.107			
				21G	(AB)7, (CD)7, (AB)4, (CD)3	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	N.A.	4.80.315 SH. 4 59304205	CONNECTION DIAGRAM FOR 59366236 OPER. ASSY DOOR	8-3.4	8-3.105			
				21H	(AB)7, (CD)7, (AB)4, (CD)3	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	N.A.	4.80.300 SH. 4 59304206	CONNECTION DIAGRAM FOR 59366226 OPER. ASSY DOOR	8-3.4	8-3.103			
				26D	B3, B5, B6 B8, A5, A6	INTERIOR LIGHTING	SEE SH. 26B (PAGE 8-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.59	VAPOR	N.A.	4.80.305 SH. 4 59304207	CONNECTION DIAGRAM FOR 59366227 OPER. ASSY DOOR	8-3.4	8-3.101			
				28A	B5, B6, B8 D5, D6, D8	ADA DOOR CHIME Car-A		8-3.3	8-3.61									
				28B	D5, D8, B5, B8	ADA DOOR CHIME Car-B		8-3.3	8-3.63									

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(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	DP	PASSENGER EMERGENCY STOP RELEASE	N.A.	32A	C4, C5, C6 D4, D5, D6	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 8-3.69) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.71	N.A.	N.A.	N.A.	N.A.	8-3.4	--	8-3.5	8-3.251	8-3.256
	DR	EXTERNAL PASSENGER PUSHBUTTON	N.A.	12D	C4,C8	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 8-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.27	VAPOR	B6, E6, E4	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.257	8-3.282
				21G	C2,D4,A4 B5,D6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B6, E6, E4, B4	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
				21H	C2,D4,A4 B5,D6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21H (PAGE 8-3.43) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B6, E6, E4, B4	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B3, B6, F6	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	GA	ADA CHIME SPEAKER	N.A.	28A	D5,D8,B5,B8	ADA DOOR CHIME Car-A		8-3.3	8-3.61	N.A.	N.A.	N.A.	N.A.	8-3.4	--	--	--	--
				28B	D5,D8,B5,B8	ADA DOOR CHIME Car-B		8-3.3	8-3.63									
	GC	ADA CHIME CENTRAL SYSTEM	N.A.	12C	C3	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 8-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.25	N.A.	N.A.	N.A.	N.A.	8-3.4	--	--	--	--
				28A	(CD)(2-3)	ADA DOOR CHIME Car-A		8-3.3	8-3.61									
				28B	(CD)(2-3)	ADA DOOR CHIME Car-B		8-3.3	8-3.63									
	GU	ADA CHIME LOCAL UNIT	N.A.	28A	B4,B7,D4,D7	ADA DOOR CHIME Car-A		8-3.3	8-3.61	N.A.	N.A.	N.A.	N.A.	8-3.4	--	--	--	--
				28B	B3,B6,D3,D6	ADA DOOR CHIME Car-B		8-3.3	8-3.63									
	LF	INTERIOR DOOR STATUS	N.A.	21G	C5,C1,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B7, E7	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	--	--	--
				21H	C5,C1,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B7, E7	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B7, E7	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B7, F7	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (cont'd)	LS	EXTERNAL DOOR STATUS	N.A.	21G	C5,C2,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B7, E4	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	--	--	--
				21H	C5,C2,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B4, E4	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	A4, E4	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B4, F7	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	LU	"DOOR OUT OF SERVICE" EXTERIOR	N.A.	21G	C5,C2,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B5, F5	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	--	--	--
				21H	C5,C2,A3,A6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B5, F6	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	C5, F6	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	C5, F4	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	LV	"DOOR OUT OF SERVICE" INTERIOR	N.A.	21G	C5,C1,A3,A5	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B5, F5, F6	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.283	8-3.300
				21H	C5,C1,A3,A5	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	B5, B6, F5, F6	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B5, B6, F5, F6	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	C5, F5	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	LX	PUSH BAR LAMP	N.A.	21G	C7,C4,A5,A7	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	B6, E6	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.301	8-3.318
				21H	C7,C4,A5,A7	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	A6, E6	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B6, E5	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B6, F6	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	NB	PULL CORD SWITCH	N.A.	43A	A3, A6, B3, B4 B5, B6	STOP REQUEST	SEE SH. 43 (PAGE 8-3.73) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.75	N.A.	N.A.	N.A.	N.A.	8-3.4	--	8-3.5	8-3.319	8-3.336
	RDO (A)	ADDITIONAL FUNCTIONS PANEL -A-	N.A.	21G	B8,C8, D8	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	BREDA	N.A.	4.00.295	RDO-A PANEL WIRING DIAGRAM	8-3.4	8-3.103	--	--	--
				31A	G8	COMMUNICATION	SEE SH. 31 (PAGE 8-3.65) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.67									
	RDO (B)	ADDITIONAL FUNCTIONS PANEL -B-	N.A.	21H	B8,C8,D8	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	BREDA	N.A.	4.00.296	RDO-B PANEL WIRING DIAGRAM	8-3.4	8-3.105	--	--	--
	RLE1	LIGHT UNDER GAPS RELAY PANEL	N.A.	26C	B4,B5	INTERIOR LIGHTING	SEE SH. 26A (PAGE 8-3.53) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.57	N.A.	N.A.	N.A.	N.A.	8-3.4		--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (cont'd)	SA	STEP MOVING EQUIPMENT	N.A.	12C	C2,C6	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 8-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.25	VAPOR	E2, B3	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.337	8-3.354
				21G	D5,D2,B3,B6	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	E2, B2	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
				21H	C5,D2,B3,B6	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	E2, B2	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
				22C	C3,C4,C5,C6 D3,D4,D5,D6	STEPS CONTROL	SEE SH. 22A (PAGE 8-3.45) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.49	VAPOR	F2, B2	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
				22D	A3,A4,A5,A6 D3,D4,D5,D6	STEPS STATUS	SEE SH. 22B (PAGE 8-3.47) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.51	VAPOR	N.A.	4.00.290 59303041	CONNECTION DIAGRAM FOR P/N 59246255 HIGH/LOW STEP ASSEMBLY A2 B2 DOORWAYS	8-3.4	8-3.101			
	SB	STEP EXTENSION EQUIPMENT	N.A.	N.A.	N.A.	N.A.	N.A.	8-3.3	--	VAPOR	E3, B4	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	--	--	--
										VAPOR	B3, F3	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	B3, F3	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B3, F4	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	SC	CUT OUT SWITCH PANEL	STEP EXTENSION CUT OUT SWITCH	21G	D6,D2,B6,C4	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	F3, C4	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.355	8-3.380
				21H	D6,D2,B6,C4	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	C3, G3	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
				22D	A3,A4,A5,A6 D3,D4,D5,D6	STEPS STATUS	SEE SH. 22C (PAGE 8-3.49) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.51	VAPOR	C3, G3	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	C3, G4	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			
	SD	STEP ALARM	N.A.	21G	A6,C5,D3,B4	DOOR ACTUATION INTERCONNECTION SCT. "A"	SEE SH. 21C (PAGE 8-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.41	VAPOR	E2, B3	4.00.227 SH. 1 59206166 SH. 1	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.87	8-3.5	8-3.381	8-3.398
				21H	A6,C5,D3,B4	DOOR ACTUATION INTERCONNECTION SCT. "B"	SEE SH. 21D (PAGE 8-3.35) FOR VEHICLES # 1400, 1401, 1403, 1449	8-3.3	8-3.43	VAPOR	E3, B3	4.00.227 SH. 2 59206166 SH. 2	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.89			
										VAPOR	E3, B3	4.00.227 SH. 3 59206166 SH. 3	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.91			
										VAPOR	B2, F3	4.00.227 SH. 4 59206166 SH. 4	SCHEM. WIRING DIAGRAM FOR S. F. MUNI LRV DOOR CONTROL AND SIGNAL SYSTEM	8-3.4	8-3.93			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	DA	OBSTRUCTION ALARM	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	--	--	--
	DF	INTERNAL PASSENGER PUSHBUTTON	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	--	--	--
	DK	INTERNAL DOOR CREW SWITCH	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-6	--	--
	DM	EXTERNAL DOOR CREW SWITCH	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-5	--	--
	DN	PASSENGER EMERGENCY STOP	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	IPC 8-52-18	--	--
	DO	DOOR OPERATOR	CONTROL UNIT 54"	4.00.209 (SH. 1 ÷ 10) 59403045 (SH. 1 ÷ 10)	SCHEMATIC WIRING DIAGRAM FOR 59347186, 59347188 & 59347190 BOARD ASSY -PC	8-3.6	8-3.401	4.80.335 (SH. 1-2) 59347190 (SH. 1-2)	BOARD ASSY – P.C. 54"	8-3.7	8-3.87	N.A.	N.A.	8-3.8	--	8-2.1	R08-02-01-00-I R08-02-01-00-S	H08-02-01-00-T
			CONTROL UNIT 47"	4.00.209 (SH. 1 ÷ 10) 59403045 (SH. 1 ÷ 10)	SCHEMATIC WIRING DIAGRAM FOR 59347186, 59347188 & 59347190 BOARD ASSY -PC	8-3.6	8-3.401	4.80.336 (SH. 1-2) 59347188 (SH. 1-2)	BOARD ASSY – P.C. 47"	8-3.7	8-3.89	N.A.	N.A.	8-3.8	--			
			CONTROL UNIT 36"	4.00.209 (SH. 1 ÷ 10) 59403045 (SH. 1 ÷ 10)	SCHEMATIC WIRING DIAGRAM FOR 59347186, 59347188 & 59347190 BOARD ASSY -PC	8-3.6	8-3.401	4.80.337 (SH. 1-2) 59347186 (SH. 1-2)	BOARD ASSY – P.C. 36"	8-3.7	8-3.91	N.A.	N.A.	8-3.8	--			
	DP	PASSENGER EMERGENCY STOP RELEASE	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.5	--	--
	DR	EXTERNAL PASSENGER PUSHBUTTON	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.11	--	--
	GA	ADA CHIME SPEAKER	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.7	R08-02-07-00-T	--
	GC	ADA CHIME CENTRAL SYSTEM	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.7	R08-02-07-00-T R08-02-07-00-I	--
	GU	ADA CHIME LOCAL UNIT	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.7	R08-02-07-00-T R08-02-07-00-I	--
	LF	INTERIOR DOOR STATUS	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-9	--	--
	LS	EXTERNAL DOOR STATUS	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-10	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.11 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DOORS AND STEPS SYSTEM CODE: 08 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II (cont'd)	LU	"DOOR OUT OF SERVICE" EXTERIOR	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-7	--	--
	LV	"DOOR OUT OF SERVICE" INTERIOR	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-7	--	--
	LX	PUSH BAR LAMP	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	IPC 8-58	--	--
	NB	PULL CORD SWITCH	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	IPC 8-52-8	--	--
	RDO	ADDITIONAL FUNCTION PANEL	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-2.8	R08-02-08-00-I	--
	RLE1	LIGHT UNDER GAPS RELAY PANEL	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	--	--	--
	SA	STEP MOVING EQUIPMENT	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-3	R08-03-00-00-C R08-03-00-00-I R08-03-00-00-S	H08-03-00-00-T
	SB	STEP EXTENSION EQUIPMENT	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-3	R08-03-00-00-C R08-03-00-00-I R08-03-00-00-S	H08-03-00-00-T
	SC	CUT OUT SWITCH PANEL	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	8-3.2	R08-03-02-00-I	--
	SD	STEP ALARM	N.A.	N.A.	N.A.	8-3.6	--	N.A.	N.A.	8-3.7	--	N.A.	N.A.	8-3.8	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.12 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: AIR COMFORT SYSTEM CODE: 09

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	HC	HVAC PACKAGE	HVAC CONTROL	12C	C3,C7	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE9-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	9-3.3	9-3.15	--	--	--	--	--	--	9-3.5	9-3.41	9-3.46
			HVAC PACKAGE	13	B4,B7	MAIN POWER WIRING DIAGRAM		9-3.3	9-3.17	SUTRAK	(HGF)(1-8)	4.00.206 1538009E	AC 38 WIRING DIAGRAM	9-3.4	9-3.31			
			HVAC LOADS	40	C2,C5	AC VOLTAGE DISTRIBUTION		9-3.3	9-3.19	SUTRAK	F(1-8)	4.00.206 1538009E	AC 38 WIRING DIAGRAM	9-3.4	9-3.31			
			SYTRONIC CONTROL	48A	C4,C5	HVAC LOW VOLTAGE CONTROL	SEE SH. 48 (PAGE 9-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	9-3.3	9-3.25	SUTRAK	(DC)4	4.00.206 1538009E	AC 38 WIRING DIAGRAM	9-3.4	9-3.31			
	HQ	CAB HEATER	CAB BLOWER	11A	C2,C6	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 9-3.9) FOR VEHICLES # 1400, 1401, 1403, 1449	9-3.3	9-3.11	--	--	--	--	--	--	9-3.5	9-3.47	9-3.52
			CAB HEATER	40	D1,D4	AC VOLTAGE DISTRIBUTION		9-3.3	9-3.19	SUTRAK	E3,D3	4.00.207 1538008E	H-8 FRONT HEATER WIRING DIAGRAM	9-3.4	9-3.33			
			CAB HEATER CONTROL	42A	C5,C4	MISCELLANEOUS		9-3.3	9-3.21	SUTRAK	G5	4.00.207 1538008E	H-8 FRONT HEATER WIRING DIAGRAM	9-3.4	9-3.33			

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	HC	HVAC PACKAGE	HVAC CONTROL	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-3.5	----	H09-03-03-02-T
			HVAC PACKAGE	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-3	R09-03-00-00-T	H09-03-00-00-T
			HVAC LOADS	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-3	R09-03-04-00-I	----
			SYTRONIC CONTROL	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-3.5.1	----	----
	HQ	CAB HEATER	CAB BLOWER	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-7	----	----
			CAB HEATER	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-7	R09-07-00-00-C R09-07-00-00-I	H09-07-00-00-I
			CAB HEATER CONTROL	N.A.	N.A.	9-3.6	--	N.A.	N.A.	9-3.7	--	N.A.	N.A.	9-3.8	--	9-7	----	H09-07-00-00-I

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.13 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: LIGHTING SYSTEM CODE: 10

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	LA	CEILING LIGHT CIRCUIT "AC CIRCUIT"	N.A.	26C	A3,A4,A5,A6	INTERIOR LIGHTING	SEE SH. 26A (PAGE 10-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.27	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.57	10-3.76
	LB	TURN LIGHT	N.A.	12D	C6	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 10-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.21	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.77	10-3.90
				27D	A3,A7	EXT. LIGHTING (TURN LIGHTS)	SEE SH. 27B (PAGE 10-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.37									
	LC	DESTINATION SIGN LIGHT BALLAST	N.A.	26C	C2,C7	INTERIOR LIGHTING	SEE SH. 26A (PAGE 10-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.27	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.91	10-3.96
	LD	DOOR AREA LIGHT	N.A.	26C	C4,C5	INTERIOR LIGHTING	SEE SH. 26A (PAGE 10-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.27	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.97	10-3.102
	LE	CEILING LIGHT CIRCUIT "EMERGENCY"	N.A.	12D	C3,C7	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 10-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.21	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.103	10-3.120
				26D	A3,A4,A7	INTERIOR LIGHTING	SEE SH. 26B (PAGE 10-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.29									
	LG	PASSENGER STOP REQUEST	N.A.	12C	C3,C7	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 10-3.15) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.19	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.121	10-3.130
				43A	B1,B2,B6,B7	STOP REQUEST	SEE SH. 43 (PAGE 10-3.39) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.41									
	LH	HEAD LIGHT	N.A.	12D	C2,C5	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 10-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.21	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.131	10-3.140
				27C	A3,A6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 10-3.31) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.35									
	LK	CAB SPOT LIGHT	N.A.	11A	C1,C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 10-3.11) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.13	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.141	10-3.146
				26C	C3,C6	INTERIOR LIGHTING	SEE SH. 26A (PAGE 10-3.23) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.27									
	LM	STEPWELL LIGHT	N.A.	26D	A3,A4,A5,A6 A7,A8	INTERIOR LIGHTING	SEE SH. 26B (PAGE 10-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.29	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.147	10-3.164
	LT	TAIL/STOP LIGHT	N.A.	12D	C2,C5	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 10-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.21	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.165	10-3.174
				27C	A3,A4,A5,A6	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 10-3.31) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.35									
	LY	HEAD LIGHT RESISTOR PANEL	N.A.	27C	B3,B6	EXT. LIGHTING TAIL, STOPAND MARKER LIGHT	SEE SH. 27A (PAGE 10-3.31) FOR VEHICLES # 1400, 1401, 1403, 1449	10-3.3	10-3.35	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.175	10-3.180
	LZ	TROUBLE LIGHT	N.A.	50A	A6	CAB AND EXTERIOR LIGHT INDICATION "A" CAR		10-3.3	10-3.43	N.A.	N.A.	N.A.	N.A.	10-3.4	--	10-3.5	10-3.181	10-3.186
				50B	A6	CAB AND EXTERIOR LIGHT INDICATION "B" CAR		10-3.3	10-3.45									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.13 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: LIGHTING SYSTEM CODE: 10 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	LA	CEILING LIGHT CIRCUIT "AC CIRCUIT"	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.1	R10-02-01-00-C R10-02-01-00-I	--
	LB	TURN LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.7	R10-02-07-00-C R10-02-07-00-I	--
	LC	DESTINATION SIGN LIGHT BALLAST	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.1.1	--	--
	LD	DOOR AREA LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.2	--	--
	LE	CEILING LIGHT CIRCUIT "EMERGENCY"	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2	R10-02-01-00-C R10-02-01-00-I	--
	LG	PASSENGER STOP REQUEST	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.5	R10-02-05-00-C R10-02-05-00-I	--
	LH	HEAD LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.8	R10-02-08-00-C R10-02-08-00-I	--
	LK	CAB SPOT LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.3	R10-02-03-00-C R10-02-03-00-I	--
	LM	STEPWELL LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.6	R10-02-06-00-C R10-02-06-00-I	--
	LT	TAIL/STOP LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.10	R10-02-10-00-C R10-02-10-00-I	--
	LY	HEAD LIGHT RESISTOR PANEL	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.9	R10-02-09-00-C R10-02-09-00-I	--
	LZ	TROUBLE LIGHT	N.A.	N.A.	N.A.	10-3.6	--	N.A.	N.A.	10-3.7	--	N.A.	N.A.	10-3.8	--	10-2.11	R10-02-11-00-C R10-02-11-00-I	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.14 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	CA	RADIO ANTENNA	N.A.	31A	C8, D7	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	H3	4.00.235 SH. 3 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.59	11-3.5	11-3.83	11-3.88
	CB	COMMUNICATION AMPLIFIER CONTROL UNIT	N.A.	31A	(CDE)5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	N.A.	4.00.233 35-4161	SCHEMATIC COMMUN. AMPLIFIER & CONTROL UNIT	11-3.4	11-3.51	11-3.5	11-3.89	11-3.96
	CD	RADIO SILENT ALARM SWITCH	N.A.	31A	A7, C3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	--	--	--	--	11-3.4	--	11-3.5	11-3.97	11-3.102
	CF	SIGNPOST RECEIVER	N.A.	31A	D8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.103	11-3.106
	CH	SPEAKER EXTERIOR	N.A.	31A	A3, A6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	A1, B1	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.107	11-3.112
	CI	INTERCOMMUNICATION UNIT PASSENGER AREA	N.A.	31A	G2, G5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	N.A.	4.00.232 10-4307	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.4	11-3.49	11-3.5	11-3.113	11-3.118
	CK	MOBILE DATA TERMINAL	N.A.	31A	(AB)8, (BC)2	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	MOTOROLA	N.A.	4.00.238 PEPS-32713-C	INTERCONNECT CABLING DIAGRAMS	11-3.4	11-3.61	11-3.5	11-3.119	11-3.128
	CL	INTERIOR SPEAKERS	N.A.	31A	A2, A3, A4, A5	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	C1	4.00.235 SH. 2 35-4199 SH. 2	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.129	11-3.146
	CM	COMMUNICATION CONTROL UNIT	N.A.	30A	(BC)3, (BC)6	CAB TO CAB INTERCOM RESET	SEE SH. 30 (PAGE 11-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.31	TCS	(BH)(7-8), (BH)(1-2)	4.00.235 SH. 1 35-4199 SH. 1	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.55	11-3.5	11-3.147	11-3.152
				31A	(DE)2, (DE)6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	(BH)(7-8)	4.00.235 SH. 2 35-4199 SH. 2	S. FRANCISCO MUNI FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57			
	CP	RADIO POWER SUPPLY	N.A.	31A	F8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	H8	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	11-3.5	11-3.153	11-3.156
	CR	RADIO EQUIPMENT	N.A.	12D	C6	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 11-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.23	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.157	11-3.160
				31A	C8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35									
	CS	GOOSENECK MICROPHONE	N.A.	31A	E2, E6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	TCS	C8, F8	4.00.235 SH. 2 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.57	--	--	--
	CV	POWER LINE FILTER	N.A.	31A	D8	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	N.A.	N.A.	N.A.	N.A.	11-3.4	--	11-3.5	11-3.161	11-3.164

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.14 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	CW	TERMINAL BOARD PANEL	N.A.	31A	E7,G7,F8,C7 D7,E6,E4,C3	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	--	--	--	--	--	--	11-3.5	11-3.165	11-3.178
	KE	MAINTENANCE TELEPHONE JACK	N.A.	42C	B3,B4,B5,B6	MISCELLANEOUS	SEE SH. 42B (PAGE 11-3.37) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.39	TCS	A(5-8)	4.00.235 SH.3 35-4199	FUNCTIONAL SCHEMATIC COMMUNICATION SYSTEM	11-3.4	11-3.59	11-3.5	11-3.179	11-3.184
	SM	SWITCH RADIO	N.A.	31A	(ABC)6	COMMUNICATION SYSTEM	SEE SH. 31 (PAGE 11-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.35	BREDA	(BC)3, (BD)3	4.00.745	WIRING DIAGRAM SWITCH RADIO	11-3.4	11-3.63	11-3.5	11-3.185	11-3.192
	TA	VIDEO SURVEILLANCE SYSTEM (PROVISION)	N.A.	N.A.	N.A.	N.A.	--	11-3.3	--	--	--	--	--	11-3.4	--	--	--	--
	TC	VIDEOCAMERA (PROVISION)	N.A.	--	--	--	--	11-3.3	--	--	--	--	--	11-3.4	--	--	--	--
	TM1	MICROPHONE FOR VIDEO SURVEILLANCE (PROVISION)	N.A.	--	--	--	--	11-3.3	--	--	--	--	--	--	--	--	--	--
	VA	TRANSPONDER	N.A.	45	A(3-7)	VETAG INTERCONNECTING		11-3.3	11-3.41	--	--	--	--	--	--	--	--	--
	VE	CODE CONTROL BOX (VETAG)	N.A.	12C	C4, C8	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 11-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.21	VAPOR	N.A.	4.92.310 28846134	BOX CODE CONTROL	11-3.4	11-3.65	11-3.5	11-3.193	11-3.198
				45	D(2-8)	VETAG INTERCONNECTING		11-3.3	11-3.41									
				27D	D2, D6	EXT. LIGHTING (TURN LIGHTS)	SEE SH. 27B (PAGE 11-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	11-3.3	11-3.27									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.14 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	CA	RADIO ANTENNA	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.9 11-2.10	R11-02-09-00-I R11-02-10-00-I	--
	CB	COMMUNICATION AMPLIFIER CONTROL UNIT	RADIO CONTROL AND CHIME GENERATOR (A1)	**4.00.266** 35-4162	**SCHEMATIC RADIO CONTROL / CHIME GENERATOR BOARD**	11-3.6	11-3.211	4.66.128 SH. 1-4 35-1159	PRINTED WIRING ASSEMBLY RADIO CNTL/CHIME GEN BD	11-3.7	11-3.223	N.A.	N.A.	11-3.8	--	11-2.3	R11-02-03-00-I	H11-02-03-00-T
			DC/DC CONVERTER (POWER SUPPLY) (A2)	**35-4008**	**SCHEMATIC DC TO DC CONVERTER**	11-3.6	11-3.213	4.66.171 35-1018	ASSEMBLY – 28V DC-TO-DC CONVERTER	11-3.7	11-3.239							
			CAB INTERCOM CONTROL (A3)	**35-4180**	**SCHEMATIC CAB INTERCOM CONTROL BOARD**	11-3.6	11-3.217	**35-1179**	PRINTED WIRING ASSEMBLY CAB INTERCOM CONTROL BD	11-3.7	11-3.265							
			PASSENGER INTERCOM CONTROL (A4)	**35-4171**	**SCHEMATIC PASSENGER INTERCOM CONTROL BOARD**	11-3.6	11-3.215	35-1170	PRINTED WIRING ASSEMBLY PASS INTERCOM CONTROL BD	11-3.7	11-3.231							
			PA COMMUNICATION CONTROL (A5)	4.00.265 35-4167	SCHEMATIC PA COMMUNICATION CONTROL BOARD	11-3.6	11-3.209	35-1166	PRINTED WIRING ASSEMBLY PA COMM CONTROL BD	11-3.7	11-3.251							
			POWER AMPLIFIER (INTERIOR SPEAKER) (A6)	**37-4041**	**SCHEMATIC POWER AMPLIFIER**	11-3.6	11-3.219	37-1040	ASSEMBLY POWER AMPLIFIER	11-3.7	11-3.271							
			POWER AMPLIFIER (EXTERIOR SPEAKER) (A7)	**37-4041**	**SCHEMATIC POWER AMPLIFIER**	11-3.6	11-3.219	37-1040	ASSEMBLY POWER AMPLIFIER	11-3.7	11-3.271							
	CD	RADIO SILENT ALARM SWITCH	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	---	11-2.13	--	--
	CF	SIGNPOST RECEIVER	N.A.	N.A.	N.A.	11-3.6	--	**N.A.**	**N.A.**	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.15	--	--
	CH	SPEAKER EXTERIOR	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.6	--	--
	CI	INTERCOMMUNICATION UNIT PASSENGER AREA	N.A.	4.00.232 10-4307	SCHEMATIC PASSENGER INTERCOM UNIT	11-3.6	11-3.49	10-1310	ASSEMBLY PASSENGER INTERCOM P.C.B.	11-3.7	11-3.243	N.A.	N.A.	11-3.8	--	11-2.4	--	--
	CK	MOBILE DATA TERMINAL	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.16	--	--
	CL	INTERIOR SPEAKERS	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.5	--	--
	CM	COMMUNICATION CONTROL UNIT	N.A.	4.00.234 35-4146	SCHEMATIC COMM. CONTROL PANEL	11-3.6	11-3.205	4.66.170 35-1151	PRINTED WIRING ASSEMBLY COMM. CONTROL PANEL	11-3.7	11-3.231	N.A.	N.A.	11-3.8	--	11-2.1	R11-02-01-00-I	--
	CP	RADIO POWER SUPPLY	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.7	R11-02-07-00-I	
	CR	RADIO EQUIPMENT	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.14	--	--
	CS	GOOSENECK MICROPHONE	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.2	--	--
	CV	POWER LINE FILTER	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.12	--	--
	CW	TERMINAL BOARD PANEL	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.14 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: COMMUNICATIONS SYSTEM CODE: 11 (CONT'D)

	BCF EQUIP. IDENT.	CODE ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II (Cont'd)	KE	MAINTENANCE TELEPHONE JACK	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-2.8	--	--
	SM	SWITCH RADIO	SM1 RADIO SWICTH	4.00.000 SH. 34	ELECTRICAL DIAGRAM P.C.B. SM1 SWITCH RADIO	11-3.6	11-3.201	4.94.360	P.C.B. LAYOUT	11-3.7	11-3.241	N.A.	N.A.	11-3.8	--	11-2.11	--	--
			SM2 RADIO SWICTH	4.00.000 SH. 34A	ELECTRICAL DIAGRAM P.C.B. SM2 SWITCH RADIO	11-3.6	11-3.203	4.94.360	P.C.B. LAYOUT	11-3.7	11-3.241	N.A.	N.A.	11-3.8	--	11-2.11	--	--
	TA	VIDEO SURVEILLANCE SYSTEM (PROVISION)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-4	R11-04-00-00-T	--
	TC	VIDEOCAMERA (PROVISION)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-4	R11-04-01-00-T	H11-04-01-00-I
	TM1	MICROPHONE FOR VIDEO SURVEILLANCE (PROVISION)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	--	--	--
	VA	TRANSPONDER	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-3.1	R11-03-01-00-I	--
	VE	CODE CONTROL BOX (VETAG)	N.A.	N.A.	N.A.	11-3.6	--	N.A.	N.A.	11-3.7	--	N.A.	N.A.	11-3.8	--	11-3.2	R11-03-02-00-I	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.15 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DESTINATION SIGN SYSTEM CODE: 12

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	FW	ATCS DESTINATION SIGN INTERFACE	N.A.	35	A5	DESTINATION SIGN CONTROL		12-3.3	12-3.33	TRANSLITE	F5	4.00.241 H 7199 SH.1	CAR WIRING DIAGRAM	12-3.4	12-3.41	12-3.5	12-3.51	12-3.54
										ALCATEL	H5	4.00.214 SH.15 3 CU 10000 ABAA EMZAA	VOBC/LRV2 INTERFACE SCHEMATIC	12-3.4	12-3.43			
	KG	RUN NUMBER SIGN	N.A.	35	B3, B6	DESTINATION SIGN CONTROL		12-3.3	12-3.33	TRANSLITE	G3, G6	4.00.241 H 7199 SH.1	CAR WIRING DIAGRAM	12-3.4	12-3.41	12-3.5	12-3.55	12-3.60
	KS	DESTINATION SIGN CONTROL UNIT	N.A.	12C	C1	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 12-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.21	TRANSLITE	F2, F7	4.00.241 H 7199 SH. 1	CAR WIRING DIAGRAM	12-3.4	12-3.41	--	--	--
				35	B2,B7	DESTINATION SIGN CONTROL		12-3.3	12-3.33									
	KX	SIDE DESTINATION SIGN	N.A.	11A	C1, C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 12-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.15	TRANSLITE	E4, E6	4.00.241 H 7199 SH. 1	CAR WIRING DIAGRAM	12-3.4	12-3.41	12-3.5	12-3.61	12-3.66
				35	B(3-4), B(5-6)	DESTINATION SIGN CONTROL		12-3.3	12-3.33									
				26C	B2, B7	INTERIOR LIGHTING	SEE SH. 26A (PAGE 12-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.27									
	KY	FRONT DESTINATION SIGN	N.A.	11A	C1, C5	L.V. DISTRIBUTION CAB BUS	SEE SH. 11 (PAGE 12-3.13) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.15	TRANSLITE	N.A.	4.00.239 H 7199 SH. 4	CAR WIRING DIAGRAM	12-3.4	12-3.39	12-3.5	12-3.67	12-3.72
				35	B2, B8	DESTINATION SIGN CONTROL		12-3.3	12-3.33	TRANSLITE	(DF)(2-3), (DF)(7-8)	4.00.241 H 7199 SH. 1	CAR WIRING DIAGRAM	12-3.4	12-3.41			
				26C	B2, B7	INTERIOR LIGHTING	SEE SH. 26A (PAGE 12-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.27									
				27C	B1, B8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 12-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.31									
	LL	RED MARKER LIGHT	N.A.	12D	C2, C6	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 12-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.23	TRANSLITE	E2, E3, E7, E8	4.00.241 H 7199 SH.1	CAR WIRING DIAGRAM	12-3.4	12-3.41	--	--	--
				27C	C2,C7,C8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 12-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.31									
	LR	GREEN MARKER LIGHT	N.A.	12D	C2, C6	L.V. DISTRIBUTION SYSTEM BUS	SEE SH. 12B (PAGE 12-3.19) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.23	TRANSLITE	E2, E3, E7, E8	4.00.241 H 7199 SH.1	CAR WIRING DIAGRAM	12-3.4	12-3.41	--	--	--
				27C	B2,B7,B8	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 12-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	12-3.3	12-3.31									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.15 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: DESTINATION SIGN SYSTEM CODE: 12 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	FW	ATCS DESTINATION SIGN INTERFACE	NA.	N.A.	N.A.	12-3.6	--	N.A.	N.A.	12-3.7	--	N.A.	N.A	12-3.8	--	--	--	--
	KG	RUN NUMBER SIGN	RUN NUMBER PCB	N.A.	N.A.	12-3.6	--	H7387	3 DIGIT LCD RUN NUMBER PCB	12-3.7	12-3.81	N.A.	N.A	12-3.8	--	12-2.3	R12-02-03-00-I	--
	KS	DESTINATION SIGN CONTROL UNIT	N.A.	N.A.	N.A.	12-3.6	--	N.A.	N.A.	12-3.7	--	N.A.	N.A	12-3.8	--	12-2.1	--	--
	KX	SIDE DESTINATION SIGN	MOTOR DECODER PCB	N.A.	N.A.	12-3.6	--	H7368 SH. 1	MOTOR / DECODER	12-3.7	12-3.77	N.A.	N.A	12-3.8	--	12-2.2	R12-02-02-00-I	--
								H7368 SH. 2	FINAL PC BOARD ASSEMBLY	12-3.7	12-3.79							
	KY	FRONT DESTINATION SIGN	MOTOR DECODER PCB	N.A.	N.A.	12-3.6	--	H7368 SH.1	MOTOR / DECODER	12-3.7	12-3.77	N.A.	N.A	12-3.8	--	12-2.1	R12-02-01-00-I	--
								H7368 SH. 2	FINAL PC BOARD ASSEMBLY	12-3.7	12-3.79							
	LL	RED MARKER LIGHT	N.A.	N.A.	N.A.	12-3.6	--	N.A.	N.A.	12-3.7	--	N.A.	N.A	12-3.8	--	12-2.1	--	--
	LR	GREEN MARKER LIGHT	N.A.	N.A.	N.A.	12-3.6	--	N.A.	N.A.	12-3.7	--	N.A.	N.A	12-3.8	--	12-2.1	--	---

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.15 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM CODE: 13

UNASSIGNED

TABLE 11-1.15 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM CODE: 14

UNASSIGNED

TABLE 11-1.18 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: PANTOGRAPH SYSTEM CODE: 15

I	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
	MB	PANTOGRAPH	N.A.	12C	C5	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 15-3.11) FOR VEHICLES # 1400, 1401, 1403, 1449	15-3.3	15-3.13	TRANSTECH	--	4.00.247 SH.1 B 86300-11-04 SH. 1	WIRING DIAGRAM FOR LOWERING DEVICE	15-3.4	15-3.23	15-3.5	15-3.33	15-3.36
										GE	G8	4.00.218 SH.1 41B569668 SH.1	SCHEMATIC SYSTEM S.F. MUNI LRV	15-3.4	15-3.25			
				13	D8	MAIN POWER WIRING DIAGRAM		15-3.3	15-3.15	GE	G7	4.00.245 SH.1 41B569659 SH.1	SCHEMATIC DIAGRAM-INV POWER SYSTEM	15-3.4	15-3.27			
				41A	B5	PANTOGRAPH CONTROL	SEE SH. 41 (PAGE 15-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	15-3.3	15-3.19	GE	E7	4.00.245 SH.3 41B569659 SH.3	SCHEMATIC DIAGRAM-INV POWER SYSTEM	15-3.4	15-3.29			

II	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
	MB	PANTOGRAPH	N.A.	N.A.	N.A.	15-3.6	--	N.A.	N.A.	15-3.7	--	N.A.	N.A.	15-3.8	--	15-2	R15-02-00-00-I R15-02-00-00-S R15-02-00-00-T	H15-02-00-00-I

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.19 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: BRAKES SYSTEM CODE: 16

I

BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
			DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
FB	AIR BRAKE CONTROL UNIT	N.A.	46A	A4, A5, A7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27	KNORR	D5, D6, D7	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.55	16-3.60
									KNORR	D(2-4)	5.86.101 X1U14614	BRAKE CONTROL UNIT EP-BGE-19D &E	16-3.4	16-3.45			
FE	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	44A	B6	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23	KNORR	G4	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.61	16-3.64
			46A	C7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27									
FF	FRICTION B. C/O STATUS	N.A.	46A	C3, C7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27	KNORR	D2	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.65	16-3.70
FG	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	44A	B5	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23	KNORR	G3	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.71	16-3.74
			46A	C4	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27									
FH	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	44A	B4	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23	KNORR	G4	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.75	16-3.78
			46A	C4	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27									
FL	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	44A	A6	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23	KNORR	G5	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.79	16-3.82
FN	BRAKE ELECTRONIC CONTROL UNIT	N.A.	46A	A4	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27	KNORR	BC(5-7)	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.83	16-3.88
FS	CUT OUT BRAKE VALVE	N.A.	46A	C4,C5,C7	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.27	KNORR	D4	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.89	16-3.96
FU	TRACK BRAKE CONTACTORS	N.A.	10	(AB)5	LOW VOLTAGE DISTRIBUTION	--	16-3.3	16-3.13	KNORR	G(6-7)	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	--	--	--
									KNORR	N.A.	4.98.310 X2U14554	TRACK BRAKE CONTACTOR ASSY	16-3.4	16-3.41			
FX	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	44A	B4	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23	KNORR	G5	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3. 97	16-3. 100
KF	FRICTION BRAKE FAULT ANNUNC. RELAYS PANEL	N.A.	46A	B4	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 16-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449		16-3.27	BREDA	N.A.	4.00.760	KF-B PANEL WIRING DIAGRAM	16-3.4	16-3.39	16-3.5	16-3.101	16-3.104
MT	TRACK BRAKE	N.A.	10	B3,B4	LOW VOLTAGE DISTRIBUTION	--	16-3.3	16-3.13	KNORR	G6, G7	4.00.230 0KB01262	ELECTRICAL INTERFACE	16-3.4	16-3.37	16-3.5	16-3.105	16-3.112
			12C	C1, C7	L.V. DISTRIBUTION AUXILIARY BUS	SEE SH. 12A (PAGE 16-3.15) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.17									
			47A	A4, A5, A7	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 16-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.31									
ND	SANDER (FOOT SWITCH)	N.A.	12C	C2	L.V. DISTRIBUTION AUXILIARY BUS	SEE SH. 12A (PAGE 16-3.15) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.17	--	--	--	--	16-3.4	--	16-3.5	16-3.113	16-3.118
			44A	D2, D7	SANDING & DUMP VALVES CONTROL	SEE SH. 44 (PAGE 16-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	16-3.3	16-3.23									
			42°	D2, D7	MISCELLANEOUS	--	16-3.3	16-3.19									

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.19 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: BRAKES SYSTEM CODE: 16 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS					MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	EQUIP. LOC	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	FB	AIR BRAKE CONTROL UNIT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	D4, D6, D7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.1	R16-02-01-00-I	H16-02-01-00-T
	FE	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	C7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.2	R16-02-02-00-I	--
	FF	FRICTION B. C/O STATUS	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	C4, C7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.2.5	--	--
	FG	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	C5	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.2	R16-02-02-00-I	--
	FH	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	C3	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.2	R16-02-02-00-I	--
	FL	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	(BC)8	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-4.3	R16-04-03-00-I	--
	FN	BRAKE ELECTRONIC CONTROL UNIT	SV1 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	D4	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.6	R16-02-06-00-I	--
			SV2 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			EPA1 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			EPA2 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			EPA3 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			PW BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			AD1 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			AD2 BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			SS BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			DI BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			CP BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
			COM BOARD	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--								
	FS	CUT OUT BRAKE VALVE	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	C4, C5, C7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-2.4	R16-02-04-00-I	--
	FU	TRACK BRAKE CONTACTORS	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	A8	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-3.3	--	H16-03-03-00-T
	FX	AUXILIARY PNEUMATIC EQUIPMENT	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	(BC)2	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-4.3	R16-04-03-00-I	--
	KF	FRICTION BRAKE FAULT ANNUNC. RELAYS PANEL	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	--	--	--	16-3.8	--	16-2.3	R16-02-03-00-I	--
	MT	TRACK BRAKE	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	5.00.000 SH. 1 1KB01179/1	A3, A5, A7	MUNI SPRING APPLIED FRICTION BRAKE SYSTEM DIAGRAM	16-3.8	16-3.123	16-3.1	R16-03-01-00-T	H16-03-01-00-I
	ND	SANDER (FOOT SWITCH)	N.A.	N.A.	N.A.	16-3.6	--	N.A.	N.A.	16-3.7	--	--	--	--	16-3.8	--	16-4.a	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.20 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: TRAIN CONTROL (ATCS) SYSTEM CODE: 17

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I	AA	ATCS "VOBC"	N.A.	12C	C6	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 17-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.19	ALCATEL	H2	4.00.214 SH. 1 3CU 10000 ABAA EMZAA SH. 1	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.73	17-3.5	17-3.123	17-3.142
				21E	B6, D6	DOOR CONTROL	SEE SH. 21A (PAGE 17-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.23	ALCATEL	D(4-6), E(4-6), G(4-5), J(5-6)	4.00.214 SH. 2 3CU 10000 ABAA EMZAA SH. 2	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.75			
				27C	D7	EXT. LIGHTING TAIL, STOP AND MARKER LIGHT	SEE SH. 27A (PAGE 17-3.25) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.27	ALCATEL	E6, H6	4.00.214 SH. 3 3CU 10000 ABAA EMZAA SH. 3	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.77			
				29A	B6	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 17-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.31	ALCATEL	H3, H4	4.00.214 SH. 4 3CU 10000 ABAA EMZAA SH. 4	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.79			
				32A	B6, C5	FULL SERVICE BRAKE	SEE SH. 32 (PAGE 17-3.33) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.35	ALCATEL	G2, G5, G8, C4	4.00.214 SH. 6 3CU 10000 ABAA EMZAA SH. 6	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.83			
				46A	D8	FRICTION BRAKE CONTROL	SEE SH. 46 (PAGE 17-3.47) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.49	ALCATEL	E2, F3	4.00.214 SH. 7 3CU 10000 ABAA EMZAA SH. 7	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.85			
				51D	(AB)(4-6)	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	ALCATEL	C4, H4	4.00.214 SH. 8 3CU 10000 ABAA EMZAA SH. 8	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.87			
				51E	(AG)(4-6)	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	ALCATEL	D4	4.00.214 SH. 9 3CU 10000 ABAA EMZAA SH. 9	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.89			
				51F	C(4-7), C(6-7)	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	ALCATEL	J5, H6	4.00.214 SH. 10 3CU 10000 ABAA EMZAA SH. 10	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.91			
				51G	A3	ATCS INTERCONNECTING WIRING TRAINLINES	--	17-3.3	17-3.67	ALCATEL	J5	4.00.214 SH. 11 3CU 10000 ABAA EMZAA SH. 11	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.93			
				--	--	--	--	--	--	ALCATEL	D7	4.00.214 SH. 12 3CU 10000 ABAA EMZAA SH. 12	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.95			
				--	--	--	--	--	--	ALCATEL	J(3-6)	4.00.214 SH. 13 3CU 10000 ABAA EMZAA SH. 13	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.97			
				--	--	--	--	--	--	ALCATEL	(AC)(5-6), J(3-7)	4.00.214 SH. 14 3CU 10000 ABAA EMZAA SH. 14	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.99			
				--	--	--	--	--	--	ALCATEL	E4, H2	4.00.214 SH. 15 3CU 10000 ABAA EMZAA SH. 15	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.101			
				--	--	--	--	--	--	ALCATEL	(EF)(1-9)	4.00.214 SH. 16 3CU 10000 ABAA EMZAA SH. 16	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.103			
				--	--	--	--	--	--	ALCATEL	D2, H3, D7, H7	4.00.214 SH. 17 3CU 10000 ABAA EMZAA SH. 17	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.105			
				--	--	--	--	--	--	ALCATEL	D4, D8	4.00.214 SH.18 3CU 10000 ABAA EMZAA SH. 18	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.107			
				--	--	--	--	--	--	ALCATEL	D(3-6), D8	4.00.214 SH.19 3CU 10000 ABAA EMZAA SH. 19	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.109			
				--	--	--	--	--	--	ALCATEL	E3	4.00.214 SH. 20 3CU 10000 ABAA EMZAA SH. 20	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.111			
				--	--	--	--	--	--	ALCATEL	(BJ)(1-2), (CD)(6-9)	4.00.214 SH. 21 3CU 10000 ABAA EMZAA SH. 21	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.113			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.20 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: TRAIN CONTROL (ATCS) SYSTEM CODE: 17 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	AB	ATCS ELECTRONIC UNIT "DU"	N.A.	12C	C2,C5	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 17-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.19	ALCATEL	C2, E2	4.00.214 SH. 1 3CU 10000 ABAA EMZAA SH. 1	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.73	17-3.5	17-3.143	17-3.152
				21E	D7, C6, D2 C4, B3, B8	DOOR CONTROL	SEE SH. 21A (PAGE 17-3.21) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.23	--	--	--	--	--	--			
				29A	A5, A6	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 17-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.31	--	--	--	--	--	--			
				51D	B2, B7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	--	--	--	--	--	--			
				51E	(FGH)2, (FGH)7	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	--	--	--	--	--	--			
				51F	D2, D7	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	--	--	--	--	--	--			
	AD	THUMBWHEEL SWITCH	N.A.	51E	C1, C8	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	ALCATEL	(CF)2, (CF)8	4.00.214 SH. 13 3CU 10000 ABAA EMZAA SH. 13	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.97	--	--	--
	AE	ATCS P-WIRE GENERATOR	N.A.	51E	B8	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	ALCATEL	B(2-6)	4.00.214 SH. 18 3CU 10000 ABAA EMZAA SH. 18	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.107	17-3.5	17-3.153	17-3.156
	AM	ATCS RECEIVE ANTENNA	N.A.	51F	A6	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	ALCATEL	B3, B5	4.00.214 SH. 16 3CU 10000 ABAA EMZAA SH. 16	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.103	--	--	--
	AN	BOX ELECTRONIC UNIT "DCB"	N.A.	51D	B2,B7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	ALCATEL	C3, E3	4.00.214 SH. 1 3CU 10000 ABAA EMZAA SH. 1	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.73	17-3.5	17-3.157	17-3.162
				51E	(DEF)1, (DEF8)	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	ALCATEL	(DH)(1-2), (DH)(7-9)	4.00.214 SH. 14 3CU 10000 ABAA EMZAA SH. 14	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.99			
				51F	D4,D5	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	--	--	--	--	17-3.4	--			
	AP	ATCS POWER SUPPLY	N.A.	12C	C5	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 17-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.19	ALCATEL	H2	4.00.214 SH. 1 3CU 10000 ABAA EMZAA SH. 1	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.73	17-3.5	17-3.163	17-3.168
				51D	(AB)7	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	ALCATEL	G(3-7)	4.00.214 SH. 19 3CU 10000 ABAA EMZAA SH. 19	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.109			
										ALCATEL	(BJ)5	4.00.214 SH. 21 3CU 10000 ABAA EMZAA SH. 21	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.113			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.20 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: TRAIN CONTROL (ATCS) SYSTEM CODE: 17 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	INTEGRATED WIRING DIAGRAMS						SUBSYSTEM INTERNAL WIRING DIAGRAMS						INTEGRATED WIRING TABLES		
				DWG 4.00.000 SHEET	EQUIP LOC	DWG 4.00.000 TITLE	NOTE	IWD MANUAL PARA	IWD MANUAL PAGE	SUPPLIER	EQUIP LOC	BCF FILE # ---------- SUPPLIER FILE #	DWG TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	IWD MANUAL PARA	IWD MANUAL FROM PAGE	IWD MANUAL TO PAGE
I (Cont'd)	AQ	ATCS SPEED SENSOR	N.A.	51F	A(4-5), A(7-8)	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	ALCATEL	H(1-5), H(5-9)	4.00.214 SH. 16 3CU 10000 ABAA EMZAA SH. 16	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.103	--	--	--
	AR	DIGITAL DISPLAY	N.A.	42C	D4,D5	MISCELLANEOUS	SEE SH. 42B (PAGE 17-3.43) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.45	ALCATEL	B2, B9	4.00.214 SH. 14 3CU 10000 ABAA EMZAA SH. 14	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.99	--	--	--
	AT	ATCS TRANSMIT ANTENNA	N.A.	51F	A5,A6	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	ALCATEL	B6, B7	4.00.214 SH. 16 3CU 10000 ABAA EMZAA SH. 16	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.103	--	--	--
	AV	ATCS ACCELEROMETER	N.A.	51D	A4	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	--	--	--	--	--	--	--	--	--
	AW	ATCS TERMINAL BOARD PANEL	N.A.	29A	B6	EMERGENCY CIRCUIT TRAIN LINE	SEE SH. 29 (PAGE 17-3.29) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.31	--	--	--	--	--	--	17-3.5	17-3.169	17-3.182
				35	C5	DESTINATION SIGN CONTROL		17-3.3	17-3.37	--	--	--	--	--	--			
				38C	A7	PROPULSION CONTROL	SEE SH. 38B (PAGE 17-3.39) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.41	--	--	--	--	--	--			
				47A	C5,C8	TRACK BRAKE CONTROL	SEE SH. 47 (PAGE 17-3.51) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.53	--	--	--	--	--	--			
				51D	B4	ATCS INTERCONNECTING WIRING TRAINLINES	SEE SH. 51A (PAGE 17-3.55) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.61	--	--	--	--	--	--			
				51E	A7,B7,C7,F6	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	--	--	--	--	--	--			
				51F	B5,B6	ATCS CHECK LOOP & TACHO INTERF.	SEE SH. 51C (PAGE 17-3.59) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.65	--	--	--	--	--	--			
				51G	B3	ATCS INTERCONNECTING WIRING TRAINLINES		17-3.3	17-3.67	--	--	--	--	--	--			
	PA	ATCS DIGITAL VOICE ANNUNCIATION	N.A.	12C	C5	L.V. DISTRIBUTION AUX. BUS	SEE SH. 12A (PAGE 17-3.17) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.19	ALCATEL	F1	4.00.214 SH. 1 3CU 10000 ABAA EMZAA SH. 1	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.73	17-3.5	17-3.183	17-3.186
				51E	G6	WIRING INTERCONNECTION ATCS EQUIP.	SEE SH. 51B (PAGE 17-3.57) FOR VEHICLES # 1400, 1401, 1403, 1449	17-3.3	17-3.63	ALCATEL	D7	4.00.214 SH. 21 3CU 10000 ABAA EMZAA SH. 21	VOBC/LRV2 INTERFACE SCHEMATICS	17-3.4	17-3.113			

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

TABLE 11-1.20 LRV2 - VEHICLES # 1400 THROUGH 1476

SYSTEM INTEGRATED WIRINGS & CIRCUIT BOARDS DATA AND DIAGRAMS/SCHEMATICS AND MAINTENANCE MANUALS CROSS REFERENCE (CONT'D)

SYSTEM: TRAIN CONTROL (ATCS) SYSTEM CODE: 17 (CONT'D)

	BCF EQUIP. IDENT. CODE	ASSEMBLY DESCRIPTION (*)	SUB-ASSEMBLY DESCRIPTION	EQUIPMENT CIRCUIT BOARD SCHEMATICS				EQUIPMENT CIRCUIT BOARD COMPONENT LAYOUTS				PIPING AND PNEUMATIC DRAWINGS				MAINTENANCE MANUALS REFERENCE		
				BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	BCF FILE # ---------- SUPPLIER FILE #	TITLE	IWD MANUAL PARA	IWD MANUAL PAGE	RMSM & HRWM PARA	R-PM SHEET	H-PM SHEET
II	AA	ATCS "VOBC"	**N.A.**	**N.A.**	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AB	ATCS ELECTRONIC UNIT "DU"	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AD	THUMBWHEEL SWITCH	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AE	ATCS P-WIRE GENERATOR	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AM	ATCS RECEIVE ANTENNA	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AN	BOX ELECTRONIC UNIT "DCB"	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AP	ATCS POWER SUPPLY	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AQ	ATCS SPEED SENSOR	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AR	DIGITAL DISPLAY	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AT	ATCS TRANSMIT ANTENNA	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AV	ATCS ACCELEROMETER	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	AW	ATCS TERMINAL BOARD PANEL	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--
	PA	ATCS DIGITAL VOICE ANNUNCIATION	N.A.	N.A.	N.A.	17-3.6	--	N.A.	N.A.	17-3.7	--	N.A.	N.A.	17-3.8	--	--	--	--

(*) FOR ASSEMBLY LOCATION ON VEHICLE, REFER TO SECTION 11-1, TABLE 11-1.2 OF THIS MANUAL

11-1.22 Trainline Wires List

A complete Trainline list is provided in Table 11-1.21 along with the Coupler Pins arrangement (fig. 11-1.26).

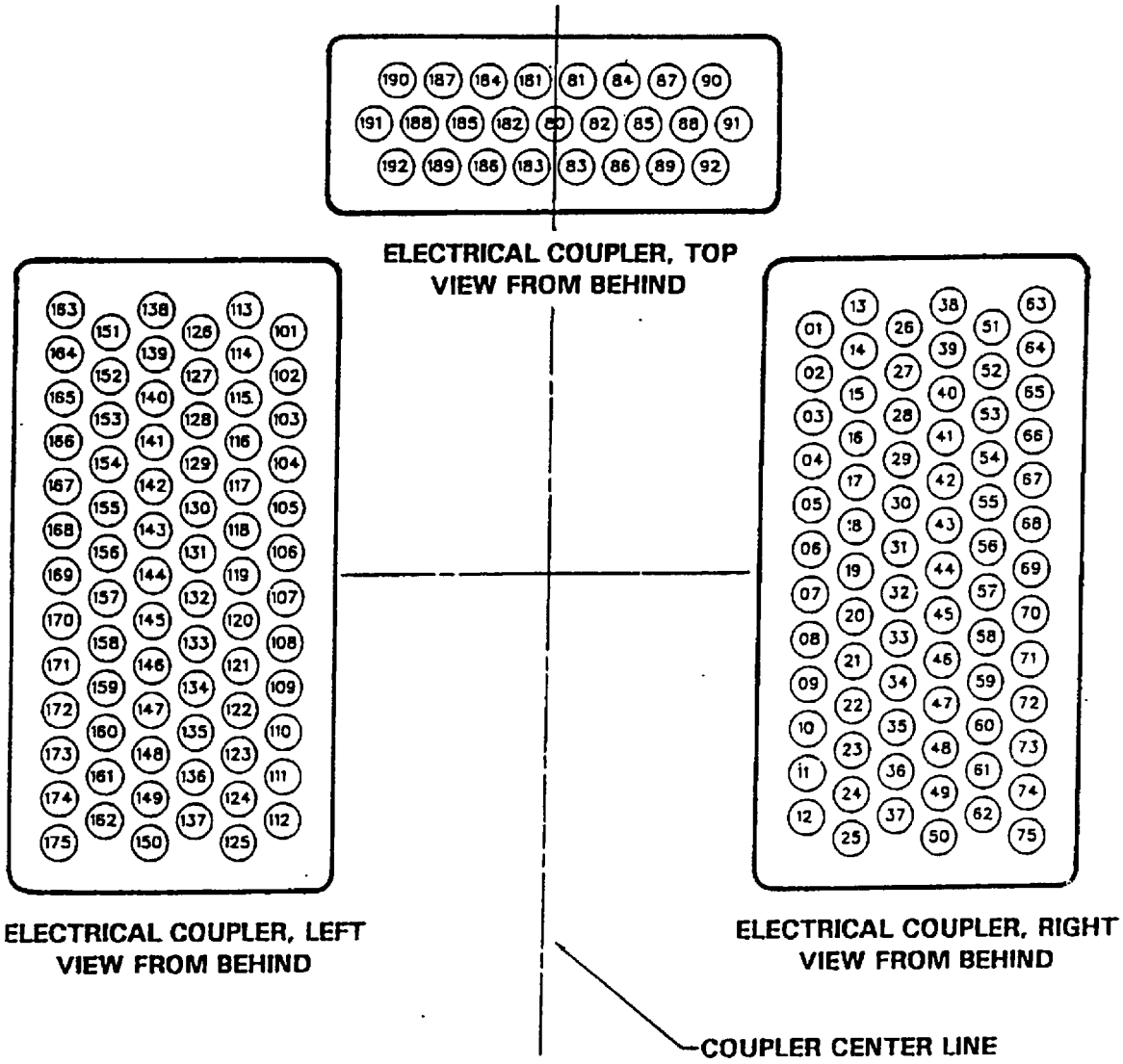

Figure 11-1.26 Coupler Pins Arrangement

Table 11-1.21 Trainline List

COUPLER ISOLATING TRAINLINES						CONNECTOR				CONNECTOR	
T/L	PIN LEFT	PIN RIGHT	CONN. TYPE	FUNCTION	WIRE NAME "A" CAR	J1	J2	SIGNAL TYPE	WIRE NAME "B" CAR	J1	J2
1		02	X	DOORS RIGHT OPEN/RELEASE/CLOSE	ET001		72	MOMENTARY B (+) OPEN	ET003	72	
2		04	X	DOORS RIGHT OPEN/RELEASE/CLOSE	ET002		74	MOMENTARY B (+) CLOSE	ET004	74	
3	102		X	DOORS LEFT OPEN/RELEASE/CLOSE	ET003	72		MOMENTARY B (+) OPEN	ET001		72
4	104		X	DOORS LEFT OPEN/RELEASE/CLOSE	ET004	74		MOMENTARY B (+) CLOSE	ET002		74
5		06	X	STEPS RIGHT HIGH	ET005		76	MOMENTARY B (+) CLOSE	ET008	76	
6		08	X	STEPS RIGHT LOW	ET006		78	MOMENTARY B (+) CLOSE	ET007	78	
7	108		X	STEP LEFT LOW	ET007	78		MOMENTARY B (+) CLOSE	ET006		78
8	106		X	STEPS LEFT HIGH	ET008	76		MOMENTARY B (+) CLOSE	ET005		76
9	109		X	STEPS LEFT HIGH STATUS	ET009	79		CONTINUOUS B (+)	ET010		79
10		09	X	STEPS RIGHT HIGH STATUS	ET010		79	CONTINUOUS B (-)	ET009	79	
11		12	X	STEPS RIGHT LOW STATUS	ET011		82	CONTINUOUS B (+)	ET012	82	
12	112		X	STEPS LEFT LOW STATUS	ET012	82		CONTINUOUS B (+)	ET011		82
13		13	X	DOORS RIGHT CLOSE STATUS	ET013		83	CONTINUOUS B (+)	ET014	83	
14	113		X	DOORS LEFT CLOSE STATUS	ET014	83		CONTINUOUS B (+)	ET013		83
15		15	X	DOOR RIGHT OPEN/RELEASE/CLOSE	ET015		85	MOMENTARY B (+) RELEASE	ET016	85	
16	115		X	DOOR LEFT OPEN/RELEASE/CLOSE	ET016	85		MOMENTARY B (+) RELEASE	ET015		85
17	117	17	N	COMMON SHIELD	ET017	113	113		ET017	113	113
18	118	18	N	HEAD-TAIL LIGHTS	ET018	87	87	CONTINUOUS	ET018	87	87
19	119	19	N	LOW AIR PRESSURE	ET019	88	88	CONTINUOUS	ET019	88	88
20		20	X	ATCS TRANSFER SWITCH INTERLOCK	ET020		89		ET020	89	
21	121	21	N	VENTILATION ON-OFF CONTROL	ET021	90	90	CONTINUOUS	ET021	90	90
22	122	22	N	PANTOGRAPH COMMAND UP	ET022	91	91	MOMENTARY	ET022	91	91
23	123	23	N	PANTOGRAPH COMMAND DOWN	ET023	92	92	MOMENTARY	ET023	92	92
24		24	X	SUMMARY DOORS RIGHT CLOSED	ET024		95	CONTINUOUS B (+)	ET025	95	
25	124		X	SUMMARY DOORS LEFT CLOSED	ET025	95		CONTINUOUS B (+)	ET024		95
26	126	26	N	SANDING COMMAND	ET026	97	97	MOMENTARY B (+)	ET026	97	97
27	127	27	N	INTERIOR LIGHTS ON	ET027	98	98	CONTINUOUS	ET027	98	98
28		29	X	TURN SIGNALS ON RIGHT	ET028		100	INTERMITTENT	ET029	100	
29	129		X	TURN SIGNALS ON LEFT	ET029	100		INTERMITTENT	ET028		100

Table 11-1.21 Trainline List (Cont'd)

COUPLER TRAINLINES (ISOLATED)						CONNECTOR				CONNECTOR	
T/L	PIN LEFT	PIN RIGHT	CONN. TYPE	FUNCTION	WIRE NAME "A" CAR	J1	J2	SIGNAL TYPE	WIRE NAME "B" CAR	J1	J2
30	130	30	N	COUPLER CONTROL	ET030	101	101	CONTINUOUS	ET030	101	101
31	131	31	N	DESTINATIONS SIGNS - SERIAL DATA	ET031	102	102	RS-485	ET031	102	102
32	132	32	N	DESTINATION SIGNS - SERIAL DATA	ET032	106	106	RS-485	ET032	106	106
33	133	33	N	TRACK BRAKE COMMAND	ET033	107	107	CONTINUOUS	ET033	107	107
34	134	34	N	TRACK BRAKE ON STATUS	ET034	108	108	CONTINUOUS B (+)	ET034	108	108
35	135	35	N	FRICTION BRAKE ON STATUS	ET035	109	109	CONTINUOUS B (+)	ET035	109	109
36	136	36	N	ATCS CUT. MODE	ET036	110	110		ET036	110	110
37	137	37	N	FRICTION BRAKE FAULT	ET037	111	111	CONTINUOUS B (+)	ET037	111	111
38	138	38	N	ATCS POWER RETURN	ET038	116	116		ET038	116	116
39	139	39	N	BRAKE DRAGGING	ET039	117	117	CONTINUOUS B (+)	ET039	117	117
40	140	40	N	REGENERATIVE BRAKE CUT OUT	ET040	118	118	CONTINUOUS B (+)	ET040	118	118
41	141	41	N	CUT OUT BYPASS STATUS INDICATION	ET041	119	119	CONTINUOUS B (+)	ET041	119	119
42	142	42	N	PASSENGER STOP REQUEST	ET042	120	120	MOMENTARY B (+)	ET042	120	120
43	143	43	N	AUXILIARY POWER SUPPLY FAILURE	ET043	125	125	CONTINUOUS B (+)	ET043	125	125
44	144	44	N	EMERGENCY (+)	ET044	126	126	CONTINUOUS B (+)	ET044	126	126
45	145	45	N	ARTICULATION DERAIL	ET045	127	127	CONTINUOUS	ET045	127	127
46	146	46	N	PASSENGER EMERGENCY DOOR RELEASE	ET046	128	128	CONTINUOUS B (+)	ET046	128	128
47	147	47	N	INTERIOR LIGHTING RETURN	ET047	129	129	CONTINUOUS	ET047	129	129
48	148	48	N	NEGATIVE TRAINLINE RETURN	ET048	130	130	CONTINUOUS B (-)	ET048	130	130
49	149	49	N	NEGATIVE TRAINLINE RETURN	ET049	134	134	CONTINUOUS B (-)	ET049	134	134
50	150	50	N	EMERGENCY (-)	ET050	135	135	CONTINUOUS B (-)	ET050	135	135
51	151	51	N	P SIGNAL	ET051	93	93	P IN	ET051	93	93
52	152	52	N	P SIGNAL	ET052	94	94	P OUT	ET052	94	94
53	153	53	N	EMERGENCY (+)	ET053	105	105	CONTINUOUS B (+)	ET053	105	105
54	154	54	N	EMERGENCY (-)	ET054	115	115	CONTINUOUS B (-)	ET054	115	115
55		56	X	DIRECTION	ET055		133	CONT. REV B (+)	ET056	133	
56	156		X	DIRECTION	ET056	133		CONT. FORW B (+)	ET055		133
57	157	57	N	PROPULSION/BRAKE MODE	ET057	136	136	CONT PROP. B (+)	ET057	136	136
58	158	58	N	PROPULSION/BRAKING	ET058	137	137	RETURN	ET058	137	137
59	159	59	N	FULL SERVICE BRAKE	ET059	138	138	CONTINUOUS B (+)	ET059	138	138
60	160	60	N	FULL SERVICE BRAKE	ET060	139	139	CONTINUOUS B (+)	ET060	139	139
61	161	61	N	INTERLOCK CABS	ET061	140	140	CONTINUOUS B (+)	ET061	140	140
62	162	62	N	INTERLOCK CABS	ET062	141	141	RETURN	ET062	141	141
63	163	63	N	PASSENGER EMERGENCY STOP INDICATION	ET063	142	142	CONTINUOUS	ET063	142	142
64	164	64	N	PROPULSION/DYNAMIC BRAKE FAULT	ET064	143	143	CONTINUOUS B (+)	ET064	143	143
65	165	65	N	CAB TO CAB INTERCOM RESET	ET065	144	144	CONTINUOUS	ET065	144	144
66	166	66	N	ZERO SPEED	ET066	145	145	CONTINUOUS B (+)	ET066	145	145
67	167	67	N	AUTO MODE ATCS	ET067	146	146	CONTINUOUS B (+)	ET067	146	146
68	168	68	N	POSITIVE TRAINLINE RETURN	ET068	147	147	CONTINUOUS B (+)	ET068	147	147
69	169	69	N	POSITIVE TRAINLINE RETURN	ET069	148	148	CONTINUOUS B (+)	ET069	148	148

Table 11-1.21 Trainline List (Cont'd)

COUPLER TRAINLINES (ISOLATED)						CONNECTOR				CONNECTOR	
T/L	PIN LEFT	PIN RIGHT	CONN. TYPE	FUNCTION	WIRE NAME "A" CAR	J1	J2	SIGNAL TYPE	WIRE NAME "B" CAR	J1	J2
70	170	70	N	TOW	ET070	149	149	CONTINUOUS B (+)	ET070	149	149
71	171	71	N	AUX ON	ET071	150	150	CONTINUOUS B (+)	ET071	150	150
72	172	72	N	AUX/OFF	ET072	151	151	CONTINUOUS B (+)	ET072	151	151
73	173	73	N	FULL SERVICE BRAKE	ET073	152	152	RETURN	ET073	152	152
74	174	74	N	FULL SERVICE BRAKE	ET074	153	153	ATCS B (+)	ET074	153	153
75	175	75	N	ZERO SPEED FOR TRACK BRAKE	ET075	154	154	CONTINUOUS	ET075	154	154
87	101	01	N	ATCS VOBC E.B.	ET087	71	71	EMERGENCY B (+)	ET087	71	71
88	103	03	N	ATCS VOBC E.B.	ET088	73	73	EMERGENCY B (-)	ET088	73	73
89	105	05	N	ATCS ACTIVE	ET089	75	75		ET089	75	75
90	107	07	N	ATCS TRAIN INTEGRITY	ET090	77	77		ET090	77	77
91		10	X	ATCS TRAIN INTEGRITY	ET091		80		ET091	80	
92	110		X	ATCS TRAIN INTEGRITY	ET092	80			ET092		80
93		14	X	ATCS CHECK LOOP	ET093		84		ET093	84	
94	114		X	ATCS CHECK LOOP	ET094	84			ET094		84
95	125	25	N	ATCS SERIAL DATA LINK	ET095	96	96		ET095	96	96
96	128	28	N	ATCS SERIAL DATA LINK	ET096	99	99		ET096	99	99
97	120		X	ATCS TRANSFER SWITCH INTERLOCK	ET097	89			ET097		89
98	111	11	N	ATCS VOBC RESET	ET098	81	81		ET098	81	81
99	116		X	ATCS AUTO CAB SELECT "A"	ET099	86			ET100		86
100		16	X	ATCS AUTO CAB SELECT "B"	ET100		86		ET099	86	
101	155	55	N	STEPS HIGH STATUS	ET101	132	132		ET101	132	132

COUPLER TRAINLINES (NOT ISOLATED)						CONNECTOR				CONNECTOR	
T/L	PIN LEFT	PIN RIGHT	CONN. TYPE	FUNCTION	WIRE NAME "A" CAR	J3		SIGNAL TYPE	WIRE NAME "B" CAR	J3	
80	80	80	N	COMMON SHIELD	ET080	U			ET080	U	
81	181	81	N	PASSENGER PUBLIC ADDRESS	ET081	L		RADIO FREQUENCY	ET081	L	
82	182	82	N	CAB INTERCOM	ET082	N		RADIO FREQUENCY	ET082	N	
83	183	83	N	CAB INTERCOM	ET083	Q		RADIO FREQUENCY	ET083	Q	
84	184	84	N	PASSENGER INTERCOM	ET084	M		RADIO FREQUENCY	ET084	M	
85	185	85	N	PASSENGER INTERCOM	ET085	P		RADIO FREQUENCY	ET085	P	
86	186	86	N	PASSENGER PUBLIC ADDRESS	ET086	V		RADIO FREQUENCY	ET086	V	

COUPLER PIN CONTROL (NOT ISOLATED)						CONNECTOR				CONNECTOR	
T/L	PIN LEFT	PIN RIGHT	CONN. TYPE	FUNCTION	WIRE NAME "A" CAR	J3		SIGNAL TYPE	WIRE NAME "B" CAR	J3	
	187			COUPLER CONTROL				JUMPER			
	188			COUPLER CONTROL	75FB-1	H		CONTINUOUS B (+)	75FB-1	H	
	189			COUPLER CONTROL	X20-13	C		CONTINUOUS B (+)	X20-13	C	
	190			COUPLER CONTROL				JUMPER			
	191			COUPLER CONTROL	75FA-1	J		CONTINUOUS B (+)	75FA-1	J	
	192			COUPLER CONTROL				JUMPER			
		87		COUPLER CONTROL	75CA-1	A		CONTINUOUS B (+)	75CA-1	A	
		88		COUPLER CONTROL	75GA-1	B		CONTINUOUS B (+)	75GA-1	B	
		89		COUPLER CONTROL				JUMPER			
		90		COUPLER CONTROL	X20-14	D		CONTINUOUS B (+)	X20-14	D	
		91		COUPLER CONTROL	75EA-1	E		CONTINUOUS B (+)	75EA-1	E	
		92		COUPLER CONTROL	NB20-9	F		CONTINUOUS B (+)	NB20-9	F	

11-1.23 Running - Preventive Maintenance Matrix (System Based)

This paragraph summarizes, in tabular form, the Preventive Maintenance Plan for the LRV2 scheduled for:

- Daily
- 1,000 Miles;
- 5,000 Miles;
- 10,000 Miles;
- 20,000 Miles;
- 40,000 Miles.

The Preventive Maintenance Plan has been designed in order to permit a 30 years structural and service vehicle life with the following basic assumptions:

- Annual vehicle miles of 40,000 Miles;
- Motor and Trailer Truck removal: every 5 years.

For every Inspection Interval the P.M. Tasks listed in the related column, has been grouped according to every main assembly, even if the tasks are pertaining different system/component.

The marker "•", in the INSPECTIONS INTERVAL columns, indicates the periodicity of the corresponding task and the alphanumerical character, in the PARA column, indicates the referenced para of the Running Maintenance and Service Manual where the procedure to be performed is described.

For Table 11-1.22 Running - Preventive Maintenance Matrix (System Based) refer to the following page.

In the Table are contained the following abbreviations:

Abbreviation	Meaning
ADA	Americans with Disabled Act
A. F.	Abbreviated Functional
C. F.	Complete Functional
RDO	Relay Door Open
VSS	Video Surveillance System

Table 11-1.22 Running Preventive Maintenance Matrix (System Based)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
2 .CAR BODY								
-ART. SECT.								
--BELLOWS	INSPECTION					●		2-5.2.c
--CAR BODY CONNECTION	INSPECTION						●	2-5.5.c
--FLOOR	INSPECTION					●		2-5.4.c
--STRUCTURE	INSPECTION					●		2-5.1.c
-OPERATOR CAB								
--CAB DIVIDING WALL	INSPECTION					●		2-4.5.c
	SERVICE						●	2-4.5.c
--EXTERNAL REAR-VIEW MIRRORS	INSPECTION					●		2-4.4.1.c
--EXTERNAL REAR-VIEW MIRRORS	SERVICE						●	2-4.4.1.c
--OPERATOR SEAT	SERVICE					●		2-4.1.c
--WINDSHIELD	INSPECTION					●		2-4.2.c
--WIPER BLADE	REPLACEMENT					●		2-4.3.4.f
--WIPER WASH SYS	SERVICE			●				2-4.3.c
-STRUCTURE								
--MAIN UNDERFRAME	CLEANING						●	2-2.1.c
	INSPECTION					●		2-2.1.c
--ROOF	CLEANING						●	2-2.4.c
	INSPECTION					●		2-2.4.c
--SKIRTS AND SPOILER	INSPECTION					●		2-2.6.c
	SERVICE					●		2-2.6.c
--WINDOWS	INSPECTION					●		2-2.5.c
-VEHICLE								
--EXTERIOR	CLEANING		●					2-2.c (b2)
	INSPECTION		●					2-2.c (c2)
--INTERIOR	CLEANING	●						2-2.c (b1)
	INSPECTION	●						2-2.c (c1)
--VEHICLE AS A WHOLE	A.F. TEST				●			2-2.d
	C.F. TEST					●		2-2.d
3 .TRUCKS AND SUSPENSION								
-AIR SUSPENSION SYSTEM								
--AIR RESERVOIR	INSPECTION						●	3-4.9.c
--AIR SPRING INFLATING COCK	INSPECTION						●	3-4.11.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
3 .TRUCKS AND SUSPENSION (cont'd)								
-AIR SUSPENSION SYSTEM								
--DOUBLE CHECK VALVE	INSPECTION						●	3-4.7.c
--DUPLEX CHECK VALVE	INSPECTION						●	3-4.5.c
--FILTER ELEMENT	CLEANING					●		3-4.2.c
--HOSE CONNECTIONS	INSPECTION						●	3-4.10.c
--LEVELING VALVE	INSPECTION					●		3-4.4.c
--OVERFLOW VALVE	TEST						●	3-4.3.d
--PRESSURE TRANSDUCER	TEST						●	3-4.8.d
--TEST FITTING	INSPECTION						●	3-4.6.c
-DERAIL WARNING SYSTEM								
--DERAIL WARNING SENSOR	INSPECTION					●		3-6.c
--DERAIL WARNING SYSTEM	TEST				●			3-6.d
-MOTOR TRUCK								
--FRAME	INSPECTION					●		3-2.2.c
--GEAR UNIT	INSPECTION				●			3-2.6.c
	SERVICE				(1)		●	3-2.6.c
--MOTOR TRUCK ASSY	CLEANING						●	3-2.c
	INSPECTION				●			3-2.c
--ODOMETER	INSPECTION					●		3-2.5.2.c
--PILOT BAR	INSPECTION	●						3-2.5.3.c
--PRIMARY SUSPENSION	INSPECTION					●		3-2.3.c
--SECONDARY SUSPENSION	INSPECTION					●		3-2.1.c
--WHEEL	INSPECTION				●			3-2.4.c
-TRAILER TRUCK								
--FRAME	INSPECTION					●		3-3.2.c
--GROUND BRUSH	INSPECTION				●			3-3.6.c
--PRIMARY SUSPENSION	INSPECTION					●		3-3.3.c
--SECONDARY SUSPENSION	INSPECTION					●		3-3.1.c
--TRAILER TRUCK ASSY	CLEANING						●	3-3.c
	INSPECTION				●			3-3.c
--WHEEL	INSPECTION				●			3-3.4.c
--WHEEL W. COMPENSATION	TEST			●				3-3.4.d

(1) First Oil Change

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
3 .TRUCKS AND SUSPENSION (cont'd)								
-VEHICLE								
--VEHICLE AS A WHOLE	LEVELING						●	3-5
4 .PROPULSION								
-BLOWER AND FILTER ASSY	CLEANING				●			4-2.2.c
	INSPECTION				●			4-2.2.c
-BRAKING RESISTOR	CLEANING				●			4-2.4.c
	INSPECTION				●			4-2.4.c
-COUPLING	INSPECTION				●			4-2.9.c
	SERVICE						●	4-2.9.c
-KNIFE SWITCH	INSPECTION				●			4-2.6.c
	TEST				●			4-2.6.d
-LINE FILTER REACTOR	INSPECTION				●			4-2.5.c
-MAIN INVERTER GROUP	CLEANING				●			4-2.1.c
	INSPECTION				●			4-2.1.c
-ROOF FUSE GROUP	INSPECTION				●			4-2.7.c
-TRACTION MOTOR	INSPECTION				●			4-2.8.c
	SERVICE						●	4-2.8.c
-LINE BREAKER GROUP								
--LB RELAY	INSPECTION				●			4-2.3.5.c
--LB GROUP	CLEANING				●			4-2.3.c
	INSPECTION					●		4-2.3.c
--LB RELAY	INSPECTION				●			4-2.3.4.c
--LINE BREAKER	INSPECTION				●			4-2.3.6.c
-MAIN INVERTER GROUP								
--MI RELAY	INSPECTION				●			4-2.1.3.c
-MASTER CONTROLLER								
--MASTER CONTROLLER	INSPECTION				●			4-3.c
5 .HV/LV								
-GONG SYSTEM								
--GONG	INSPECTION						●	5-2.14.c
--GONG SYSTEM	TEST			●				5-2.14.d

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
5 .HV/LV (cont'd)								
-HIGH VOLTAGE SYSTEM								
--AUXILIARY POWER GROUP	CLEANING				●			5-2.1.c
	INSPECTION				●			5-2.1.c
	TEST						●	5-2.1.d
--AUXILIARY POWER GROUP - BLOWER MOTOR STARTER	INSPECTION			●				5-2.1.6.c
--AUXILIARY POWER GROUP - FILTER	CLEANING				●			5-2.1.13.c
	INSPECTION				●			5-2.1.13.c
--HIGH VOLTAGE FUSE BOX	CLEANING						●	5-2.2.c
	INSPECTION						●	5-2.2.c
--HIGH VOLTAGE GROUND PLATE	INSPECTION					●		5-2.3.c
-LOW VOLTAGE SYSTEM								
--AUXILIARY ON SWITCH	INSPECTION					●		5-2.5.c
--AUXILIARY RELAY PANEL - KQ	CLEANING						●	5-2.12.c
	INSPECTION						●	5-2.12.c
--AUXILIARY RELAY PANEL - KR	CLEANING						●	5-2.13.c
	INSPECTION						●	5-2.13.c
--BATTERY	CLEANING					●		5-2.6.2.c
	INSPECTION				●			5-2.6.2.c
	SERVICE				●			5-2.6.2.c
	TEST					●		5-2.6.2.d
--BATTERY BOX ASSY	CLEANING				●			5-2.6.1.c
	INSPECTION					●		5-2.6.1.c
--BATTERY CIRCUIT BREAKER	INSPECTION					●		5-2.6.3.c
	TEST					●		5-2.6.3.d
--BYPASS PANEL	INSPECTION			●				5-2.10.c
--LOW VOLTAGE CONTROL BOX	CLEANING						●	5-2.4.c
	INSPECTION						●	5-2.4.c
--LV CIRCUIT BREAKER PANEL	INSPECTION			●				5-2.8.c
--OPERATOR CONSOLE	INSPECTION			●				5-2.9.c
--TERMINAL BOARD PANEL	CLEANING						●	5-2.11.c
	INSPECTION						●	5-2.11.c
--TRAINLINE JUNCTION BOX	INSPECTION					●		5-2.7.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
5 .HV/LV (cont'd)								
-STOP REQUEST SYSTEM								
--STOP REQUEST SYSTEM	INSPECTION						●	5-2.17.c
	TEST			●				5-2.17.d
-UNDER ROOF TERMINAL BOARDS								
--UNDER ROOF TERMINAL BOARDS	INSPECTION						●	5-2.16.c
6 .AIR COMPRESSOR/ PNEUMATIC SYS								
-AIR RESERVOIR	INSPECTION						●	6-2.2.c
-AIR RESERVOIR	SERVICE				●			6-2.2.c
-CUT-OUT COCKS	INSPECTION						●	6-2.3.c
-HOSE CONNECTIONS	INSPECTION						●	6-2.4.c
-AIR SUPPLY UNIT								
--AIR COMPRESSOR	INSPECTION					●		6-2.1.1.c
	SERVICE					●		6-2.1.1.c
--AIR FILTER	CLEANING					●		6-2.1.9.c
	INSPECTION					●		6-2.1.9.c
--AIR SUPPLY UNIT	CLEANING				●			6-2.1.c
	INSPECTION				●			6-2.1.c
	TEST					●		6-2.1.d
--COMPRESSOR MOTOR	CLEANING					●		6-2.1.2.c
	INSPECTION					●		6-2.1.2.c
--HVDC MOTOR CONTACTOR	INSPECTION						●	6-2.1.4.c
--LVDC TERMINAL BOX	INSPECTION						●	6-2.1.5.c
--PRESSURE SWITCH	INSPECTION						●	6-2.1.6.c
--SAFETY VALVES	INSPECTION					●		6-2.1.7.c
	TEST						●	6-2.1.7.c
--TEST FITTING	INSPECTION						●	6-2.1.8.c
--TWIN TOWER AIR DRYER	CLEANING						●	6-2.1.3.c
	INSPECTION					●		6-2.1.3.c
	SERVICE						●	6-2.1.3.c
-HORN SYSTEM								
--CUT-OUT COCK	INSPECTION						●	6-3.1.c
--HORN	INSPECTION						●	6-3.3.c
--HORN SYSTEM	TEST				●			6-3.d

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
6 .AIR COMPRESSOR/ PNEUMATIC SYS (cont'd)								
-HORN SYSTEM								
--MAGNET VALVE	INSPECTION						●	6-3.2.c
7 .COUPLER								
-CENTERING DEVICE	INSPECTION					●		7-2.1.4.c
-COUPLER ASSY	ADJUSTMENT						●	7-2.d
	CLEANING				●			7-2.c
	INSPECTION				●			7-2.c
	SERVICE				●			7-2.c
-DRAFT GEAR AND BUFFER ASSY	INSPECTION					●		7-2.1.2.c
-ELECTRICAL COUPLER - TOP	CLEANING				●			7-2.2.2.c
	INSPECTION			●				7-2.2.2.c
-ELECTRICAL COUPLERS - LH/RH	CLEANING				●			7-2.2.1.c
	INSPECTION			●				7-2.2.1.c
-LIMIT SWITCH	INSPECTION						●	7-2.2.5.c
-MANUAL UNCOUPLING DEVICE	INSPECTION			●				7-2.1.5.c
-MECHANICAL COUPLER HEAD	INSPECTION			●				7-2.1.1.c
-SUSPENSION ATTACHMENT	INSPECTION				●			7-2.2.4.c
-VERTICAL SUPPORT	INSPECTION					●		7-2.1.3.c
-PNEUMATIC SYSTEM								
--AIR FILTER	CLEANING				●			7-2.3.5.c
	INSPECTION				●			7-2.3.5.c
--CUT-OUT COCK	INSPECTION						●	7.2.3.4.c
--PNEUMATIC UNCOUPLING VALVE	INSPECTION						●	7-2.3.6.c
8 .DOORS								
-ADA DOOR CHIME SYSTEM								
--ADA DOOR CHIME SYSTEM	INSPECTION						●	8-2.7.c
	TEST			●				8-2.7.d
-CUT OUT VALVE PANELS								
--CUT OUT VALVE PANELS	INSPECTION						●	8-3.1.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
8 .DOORS (cont'd)								
-DOORS SYSTEM								
--DOOR OPERATOR ASSY	INSPECTION			●				8-2.1.c
--DOOR OPERATOR ASSY	SERVICE			●				8-2.1.c
--DOOR PANEL ASSY	INSPECTION					●		8-2.2.c
--DOOR PANEL ASSY	SERVICE			●				8-2.2.c
--DOOR PANEL ASSY	SYNCHRONIZE			●				8-2.d
--DOOR PANEL ASSY	TIMING					●		8-2.d
-RELAY PANELS (RDO)								
--RELAY PANELS	INSPECTION						●	8-2.8.c
-STEP CUT OUT SWITCH PANELS								
--STEP CUT OUT SWITCH PANEL	INSPECTION						●	8-3.2.c
-STEPS SYSTEM								
--STEPS ASSY	CLEANING				●			8-3.c
--STEPS ASSY	INSPECTION				●			8-3.c
--STEPS ASSY	SERVICE				●			8-3.c
9 .HVAC								
-AIR DIFFUSERS	CLEANING				●			9-6.c
	INSPECTION				●			9-6.c
-CAB HEATER UNIT	CLEANING						●	9-7.c
	INSPECTION						●	9-7.c
-CLIMATE CONTROL UNIT - CONDENSER SECT.	INSPECTION				●			9-3.1.c
-CLIMATE CONTROL UNIT - EVAPORATOR SECT.	INSPECTION				●			9-3.2.c
-CLIMATE CONTROL UNIT ASSY	TEST					●		9-3.d
-FRESH AIR OPENING AND FILTER	INSPECTION			●				9-3.2.1.c
-INLET DUCT	CLEANING						●	9-5.c
	INSPECTION						●	9-5.c
-SUCTION DUCT	CLEANING			●				9-4.c
	INSPECTION		●					9-4.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
9 .HVAC (cont'd)								
-CLIMATE CONTROL UNIT M/C SECTION								
--CLIMATE CONTROL UNIT - M/COMPR. SECT.	INSPECTION				●			9-3.3.c
--CLIMATE CONTROL UNIT - M/COMPR. UNIT	INSPECTION					●		9-3.4.c
-CLIMATE CONTROL UNIT								
--CONDENSER SECTION AND COILS	CLEANING						●	9-3.1.c
--EVAPORATOR SECTION AND COILS	CLEANING						●	9-3.2.c
10.LIGHTING								
-LIGHTING SYSTEM								
--AIR LIGHT FIXTURE	CLEANING					●		10-2.1.c
	INSPECTION			●				10-2.1.c
--ARTICULATION LIGHT	CLEANING					●		10-2.4.c
	INSPECTION			●				10-2.4.c
--CAB SPOT LIGHT	CLEANING					●		10-2.3.c
	INSPECTION			●				10-2.3.c
--FARE BOX LIGHT	CLEANING					●		10-2.2.c
	INSPECTION			●				10-2.2.c
--HEAD LIGHT	CLEANING					●		10-2.8.c
	INSPECTION		●					10-2.8.c
--HEAD LIGHT RESISTOR PANEL	CLEANING					●		10-2.9.c
--HEAD LIGHT RESISTOR PANEL	INSPECTION					●		10-2.9.c
--LIGHTING SYSTEM	TEST			●				10-2.d
--STEPWELL LIGHT	CLEANING					●		10-2.6.c
	INSPECTION			●				10-2.6.c
--STOP REQUEST LIGHT	CLEANING					●		10-2.5.c
	INSPECTION			●				10-2.5.c
--STOP/TAIL LIGHT	CLEANING					●		10-2.10.c
	INSPECTION		●					10-2.10.c
--TROUBLE LIGHT	CLEANING					●		10-2.11.c
	INSPECTION		●					10-2.11.c
--TURN INDICATOR LIGHT	CLEANING					●		10-2.7.c
	INSPECTION		●					10-2.7.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
11.COMMUNICATIONS								
-COMMUNICATION SYSTEM								
--ANTENNA - 148/160 MHz	INSPECTION				●			11-2.9.c
--ANTENNA - 470/488 MHz	INSPECTION				●			11-2.10.c
--COMMUNICATION AMPLIFIER AND C.U.	INSPECTION				●			11-2.3.c
--COMMUNICATION CONTROL PANEL	INSPECTION				●			11-2.1.c
--RADIO POWER SUPPLY	INSPECTION				●			11-2.7.c
--SWITCH RADIO BOX	INSPECTION						●	11-2.11.c
-VETAG SYSTEM								
--VETAG CONTROL PANEL	INSPECTION				●			11-3.2.c
--VETAG TRASPONDER	INSPECTION					●		11-3.1.c
-VIDEO SURVEILLANCE SYSTEM								
--VIDEOCAMERA	INSPECTION				●			11-4.c
--VSS EQUIPMENT	INSPECTION				●			11-4.c
--VSS SYSTEM	TEST				●			11-4.d
12.DESTINATION SIGN								
-END DESTINATION SIGN	INSPECTION						●	12-2.1.c
-RUN NUMBER SIGN	INSPECTION						●	12-2.3.c
-SIDE DESTINATION SIGN	INSPECTION						●	12-2.2.c
-DESTINATION SIGN SYSTEM								
--DESTINATION SIGN SYSTEM	TEST				●			12-2.d
15.PANTOGRAPH								
-PANTOGRAPH ASSY	INSPECTION					●		15-2.c
	SERVICE					●		15-2.c
	TEST					●		15-2.d
16.BRAKES								
-FRICTION BRAKE SYSTEM								
--AIR RESERVOIR	INSPECTION					●		16-2.7.c
--BRAKE CALIPER	SERVICE						●	16-2.12.c

Table 11-1.22 Running Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM / ASSEMBLIES / COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED						RMSM PARA
		Daily	1,000	5,000	10,000	20,000	40,000	
16.BRAKES (cont'd)								
-FRICTION BRAKE SYSTEM								
--BRAKE CALIPER AND PADS	INSPECTION					●		16-2.12.c(2)
	INSPECTION			●				16-2.12.c(1)
--BRAKE CONTROL UNIT	INSPECTION			●				16-2.1.c
--BRAKE DISC	INSPECTION					●		16-2.11.c(2)
	INSPECTION			●				16-2.11.c(1)
--CHECK VALVE	INSPECTION						●	16-2.8.c
--CUT-OUT BRAKE VALVE	INSPECTION				●			16-2.4.c
--DEAD MAN CIRCUIT	TEST	●						16-2.d
--ELECTRONIC CONTROL UNIT	INSPECTION		●					16-2.6.c
--EMERGENCY CIRCUIT	TEST				●			16-2.d (b2)
--FAULT RELAY PANEL	INSPECTION			●				16-2.3.c
--FRICTION BRAKE	TEST				●			16-2.d (b1)
--HOSE CONNECTIONS	INSPECTION						●	16-2.13.c
--PNEUMATIC PACKAGE	INSPECTION			●				16-2.2.c
--PRESSURE SWITCH	INSPECTION			●				16-2.2.5.c
--QUICK APPLICATION VALVE	INSPECTION						●	16-2.9.c
--TEST FITTING	INSPECTION						●	16-2.10.c
-SANDING SYSTEM								
--AUX PNEUMATIC PACKAGE	INSPECTION			●				16-4.3.c
--SAND BOXES	SERVICE		●					16-4.1.c
--SAND EJECTORS	INSPECTION					●		16-4.2.c
--SANDING SYSTEM	TEST			●				16-4.d
-TRACK BRAKE SYSTEM								
--TRACK BRAKE	INSPECTION					●		16-3.1.c
--TRACK BRAKE SPRING SUSPENSION	INSPECTION					●		16-3.2.c
--TRACK BRAKE SYSTEM	TEST						●	16-3.1.d

11-1.24 Heavy - Preventive Maintenance Matrix (System Based)

This paragraph summarizes, in tabular form, the Heavy - Preventive Maintenance Plan for the LRV2 fleet scheduled as follows:

- 100,000 Miles Inspection;

- 200,000 Miles Inspection;

- 400,000 Miles Inspection.

The Preventive Maintenance Plan has been designed to permit a 30 years structural and service vehicle life with the following basic assumptions:

- Annual vehicle miles of 40,000 Miles;

- Motor and Trailer Truck removal at 200,000 Miles.

For every Inspection Interval the P.M. Tasks listed in the related column, are grouped according to the main assembly even if the tasks pertain to different system/component.

The marker "●", in the INSPECTIONS INTERVAL column, indicates the periodicity of the corresponding task. The PARA column, indicates the referenced Para of the Heavy Repair and Workshop Manual (HRWM) where the procedure to be performed is described.

For Table 11-1.23 Heavy Preventive Maintenance Matrix (System Based) refer to the following pages.

Table 11-1.23 Heavy - Preventive Maintenance Matrix (System Based)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
2. CAR BODY					
- ART. SECT.					
-- CAR BODY CONNECTION	INSPECTION		●		2-5.5.g
- STRUCTURE					
-- MAIN UNDERFRAME	INSPECTION		●		2-2.1.g
-- ROOF	INSPECTION		●		2-2.4.g
3. TRUCK AND SUSPENSION					
- AIR SUSPENSION SYSTEM					
-- AIR RESERVOIR	INSPECTION			●	3-4.9.g
-- AIR SPRING INFLATING COCK	REPLACEMENT		●		3-4.11.d-k
-- CUT-OUT COCK	INSPECTION		●		3-4.1.g
-- DOUBLE CHECK VALVE	REPLACEMENT		●		3-4.7.d-k
-- DUPLEX CHECK VALVE	INSPECTION		●		3-4.5.g
-- HOSE CONNECTIONS	REPLACEMENT		●		3-4.10.d-k
-- LEVELING VALVE	INSPECTION	●			3-4.4.g
-- OVERFLOW VALVE	INSPECTION		●		3-4.3.g
-- PRESSURE TRANSDUCER	REPLACEMENT		●		3-4.8.d-k
-- TEST FITTING	INSPECTION		●		3-4.6.g
- MOTOR TRUCK					
-- AIR SPRINGS	REPLACEMENT			●	3-2.1.5.d-k
-- BUMP STOPS	REPLACEMENT		●		3-2.1.3.d-k
-- CONNECTING ROD - RUBBER ELEMENTS	REPLACEMENT		●		3-2.1.6.d-k
-- FRAME	INSPECTION		●		3-2.2.g
-- GEAR UNIT	INSPECTION			● (15Y)	3-2.6.g

Table 11-1.23 Heavy – Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- MOTOR TRUCK (cont'd)					
-- GEAR UNIT	TEST			● (15Y)	3-2.6.j
-- MOTOR TRUCK ASSY	INSPECTION		●		3-2.g
-- PRIMARY SUSPENSION	REPLACEMENT		●		3-2.3.d-k
-- SHOCK ABSORBERS	REPLACEMENT		●		3-2.1.4.d-k
-- SLEWING RING	LUBRICATION		●		3-2.1.1.i
-- WHEEL SET ASSY	INSPECTION			● (15Y)	3-2.4.g
- TRAILER TRUCK					
-- AIR SPRINGS	REPLACEMENT			●	3-3.1.5.d-k
-- BUMP STOPS	REPLACEMENT		●		3-3.1.3.d-k
-- CONNECTING ROD - RUBBER ELEMENTS	REPLACEMENT		●		3-3.1.6.d-k
-- FRAME	INSPECTION		●		3-3.2.g
-- GROUND BRUSH	INSPECTION			●	3-3.6.g
-- PRIMARY SUSPENSION	REPLACEMENT		●		3-3.3.d-k
-- SHOCK ABSORBERS	REPLACEMENT		●		3-3.1.4.d-k
-- SLEWING RING	LUBRICATION		●		3-3.1.1.i
-- TRAILER TRUCK ASSY	INSPECTION		●		3-3.g
-- WHEEL SET ASSY	INSPECTION			● (15 Y)	3-3.4.g
4. PROPULSION					
- BLOWER AND FILTER ASSY	INSPECTION	●			4-2.2.g
- BLOWER AND FILTER ASSY	OVERHAUL	●			4-2.2.h
- BLOWER AND FILTER ASSY	TEST	●			4-2.2.j
- BRAKING RESISTOR	TEST	●			4-2.4.j
- COUPLING	INSPECTION			● (15Y)	4-2.9.g

Table 11-1.23 Heavy - Preventive Maintenance Matrix (System Based)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- KNIFE SWITCH	INSPECTION		●		4-2.6.g
- KNIFE SWITCH	OVERHAUL		●		4-2.6.h
- KNIFE SWITCH	TEST		●		4-2.6.j
- LINE BREAKER GROUP	INSPECTION	●			4-2.3.g
- LINE BREAKER GROUP	OVERHAUL	●			4-2.3.h
- LINE BREAKER GROUP	TEST	●			4-2.3.j
- LINE FILTER REACTOR	TEST	●			4-2.5.j
- MAIN INVERTER GROUP	TEST		●		4-2.1.j
-- TRACTION MOTOR	INSPECTION		●		4-2.8.g
-- TRACTION MOTOR	OVERHAUL		●		4-2.8.h
-- TRACTION MOTOR	TEST		●		4-2.8.j
- MASTER CONTROLLER					
-- MASTER CONTROLLER	INSPECTION		●		4-3.g
-- MASTER CONTROLLER	TEST	●			4-3.j
5. HV/LV					
-HIGH VOLTAGE SYSTEM					
--AUXILIARY POWER GROUP	TEST		●		5-2.1.1.j
6. AIR COMPRESSOR / **PNEUMATIC SYSTEM**					
- HOSE CONNECTION	REPLACEMENT		●		6-2.4.d-k
- AIR RESERVOIR					
-- AIR RESERVOIR	INSPECTION			●	6-2.2.g
-- CUT-OUT COCK	INSPECTION		●		6-2.3.g

Table 11-1.23 Heavy – Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- AIR SUPPLY UNIT					
-- AIR COMPRESSOR	INSPECTION		●		6-2.1.1.h
-- AIR SUPPLY UNIT	TEST		●		6-2.1.j
-- COMPRESSOR MOTOR	INSPECTION		●		6-2.1.2.g
-- HVDC MOTOR CONTACTOR	INSPECTION		●		6-2.1.4.g
-- LVDC TERMINAL BOX	INSPECTION		●		6-2.1.5.g
-- PRESSURE SWITCH	INSPECTION		●		6-2.1.6.g
-- TEST FITTING	INSPECTION		●		6-2.1.8.g
-- TWIN TOWER AIR DRYER	INSPECTION		●		6-2.1.3.g
- HORN SYSTEM					
-- CUT-OUT COCK	INSPECTION		●		6-3.1.g
-- MAGNET VALVE	INSPECTION		●		6-3.2.g
7. COUPLER					
- CENTERING DEVICE	INSPECTION		●		7-2.1.4.g
- DRAFT GEAR AND BUFFER ASSY	INSPECTION		●		7-2.1.2.g
- ELECTRICAL COUPLER - TOP	INSPECTION		●		7-2.2.2.g
- ELECTRICAL COUPLERS - LH/RH	INSPECTION		●		7-2.2.1.g
- MANUAL UNCOUPLING DEVICE	INSPECTION		●		7-2.1.5.g
- MECHANICAL COUPLER HEAD	INSPECTION		●		7-2.1.1.g
- SUSPENSION ATTACHMENT	INSPECTION		●		7-2.2.4.g
- VERTICAL SUPPORT	INSPECTION		●		7-2.1.3.g
- PNEUMATIC SYSTEM					
-- CUT-OUT COCK	REPLACEMENT		●		7-2.3.4.d-k

Table 11-1.23 Heavy - Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- PNEUMATIC SYSTEM (cont'd)					
-- MRP VALVE	INSPECTION		●		7-2.3.1.g
-- OPERATING DEVICE	INSPECTION		●		7-2.3.3.g
-- PNEUMATIC UNCOUPLING VALVE	INSPECTION		●		7-2.3.6.g
-- UNCOUPLING DEVICE	INSPECTION				7-2.3.2.g
8. DOORS					
- DOORS SYSTEM					
-- DOOR OPERATOR ASSY	TEST	●			8-2.1.j
-- DOOR PANEL ASSY	TEST	●			8-2.2.j
- STEPS SYSTEM					
-- STEPS ASSY	TEST	●			8-3.j
9. HVAC					
- CAB HEATER UNIT	INSPECTION		●		2-7.g
- CLIMATE CONTROL UNIT ASSY	INSPECTION		●		2-3.g
- CLIMATE CONTROL UNIT ASSY	TEST		●		2-3.j
- FIBERGLASS HOUSING	CLEANING		●		2-3.6.f
- HIGH PRESSURE SWITCH	TEST	●			2-3.3.j
- LOW PRESSURE SWITCH	TEST	●			2-3.3.j
- MOTOR COMPRESSOR UNIT	INSPECTION		●		2-3.4.h
10. LIGHTING					
- N/A					

Table 11-1.23 Heavy – Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
11. COMMUNICATIONS					
- COMMUNICATION AMPLIFIER AND C.U.	TEST	●			11-2.3.j
- VIDEO SURVEILLANCE SYSTEM					
-- VIDEOCAMERA	INSPECTION	●			11-4.1.g
-- VSS EQUIPMENT	INSPECTION	●			11-4.2.g
12. DESTINATION SIGN					
- N/A					
13. Unassigned					
14. Unassigned					
15. PANTOGRAPH					
- PANTOGRAPH ASSY	INSPECTION		●		15-2.g
16. BRAKES					
- AUX PNEUMATIC PACKAGE					
-- CUT-OUT COCK	INSPECTION		●		16-4.3.1.g
-- MAGNET VALVE	INSPECTION		●		16-4.3.2.g
-- SAND EJECTOR	INSPECTION	●			16-4.2.g
- BRAKE CONTROL UNIT					
-- ANALOG CONVERTER	INSPECTION	●			16-2.1.1.g
-- EMERGENCY MAGNET VALVE	INSPECTION	●			16-2.1.4.g
-- PRESSURE LIMIT VALVE	INSPECTION	●			16-2.1.2.g

Table 11-1.23 Heavy – Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- BRAKE CONTROL UNIT (cont'd)					
-- PRESSURE TRANSDUCER	REPLACEMENT		●		
-- RELAY VALVE	INSPECTION	●			16-2.1.3.g
-- TEST FITTING	INSPECTION	●			16-2.1.5.g
- FRICTION BRAKE SYSTEM					
-- AIR RESERVOIR	INSPECTION			●	16-2.7.g
-- BRAKE CALIPER	INSPECTION		●		16-2.12.g
-- BRAKE CONTROL UNIT	TEST	●			16-2.1.j
-- BRAKE DISC	INSPECTION		●		16-2.11.g
-- CHECK VALVE	REPLACEMENT		●		16-2.8.d/k
-- DUAL AIR PRESSURE GAUGE	TEST	●			16-2.5.g
-- HOSE CONNECTIONS	REPLACEMENT		●		16-2.13.d/k
-- PRESSURE SWITCH	INSPECTION	●			16-2.2.5.g
-- QUICK APPLICATION VALVE	INSPECTION		●		16-2.9.g
-- TEST FITTING	INSPECTION		●		16-2.10.g
- PNEUMATIC PACKAGE					
-- CUT-OUT COCK	INSPECTION	●			16-2.2.2.g
-- DUMP MAGNET VALVE	INSPECTION	●			16-2.2.1.g
-- PRESSURE REDUCING VALVE	INSPECTION	●			16-2.2.3.g
-- PRESSURE SWITCH	INSPECTION	●			16-2.2.5.g
-- RAPID VENT VALVE	INSPECTION	●			16-2.2.6.g
-- TEST FITTING	INSPECTION	●			16-2.2.4.g

Table 11-1.23 Heavy – Preventive Maintenance Matrix (System Based) (cont'd)

SYSTEM/ ASSEMBLIES/ COMPONENTS	TASK	INSPECTION INTERVAL MILEAGE BASED			HRWM PARA
		100,000	200,000	400,000	
- TRACK BRAKE SYSTEM					
-- TRACK BRAKE	INSPECTION		●		16-3.1.g
-- TRACK BRAKE CONTACTORS	TEST	●			16-3.3.g
-- TRACK BRAKE SPRING SUSPENSION	INSPECTION		●		16-3.2.g

11-1.25 Running Maintenance - List of Consumable Materials

In Table 11-1.24 are listed the Consumable Materials necessary to accomplish the Running Preventive Maintenance Tasks listed in the Preventive Maintenance Matrix (System Based).

Table 11-1.24 Running Maintenance - List of Consumable Materials

SECT	SYSTEM/ASSY	DESCRIPTION	P/N
2	CAR BODY	JET-LUBE 769 LUBRICANT	
	Rear-View Mirror	SHELL Alvania #2	
		Rags	
		No rinse multipurpose detergent	
	Operator Seat and Cab Door	Shell HD 30 oil	
3	TRUCK AND SUSPENSION	Knorr L2 filter	I/47890
		O-ring for same	A36933
4/5	PROPULSION and HV/LV DISTRIBUTION	Fuse 2A Fuse 80A Fuse 125A Fuse 160A Fuse 160A Fuse 25A Fuse 50A Fuse 6A (FERRAZ)	R07492160 R07492142 R07492139 R07492138 R07492135 R07492134 R07492132 CC1051CPRB20
		Main inverter gaskets	156B1886BJP224 156B1886BJP122 156B1886BJP203
		-Washers -Lockwashers -Bolts -Latches -Hinges pins	N400P42 N406P42 N24P23012 341B571G4 41A326796P1
		Aux inverter gaskets	156B1886BHP99 156B1886BHP156 156B1886BHP190 156B1886BHP243 156B1886BHP173

Table 11-1.24 Running Maintenance - List of Consumable Materials (Cont'd)

SECT	SYSTEM/ASSY	DESCRIPTION	P/N
4/5	PROPULSION and HV/LV DISTRIBUTION (cont'd)	Aux inverter gaskets (cont'd)	156B1886BHP52 156B1886BHP62 156B1886BHP81 156B1886BHP120
		-Gaskets	156B1886BHP143
		-Washers	N400P42
		-Lockwashers	N406P42
		-Bolts	N24P23010
		-Latches	341B571G5
		-Hinges pins	41A326796P1
		Gear unit cover gasket	41A330452P1
		Cement C&B Rubber CB 1000	497A806P57
		Sealant HUBBS & HOME - Permatex #3	497A806P32
	Gear Unit	SHELL HD 80W90 Oil	
	Motor Bearings	SHELL ALVANIA n.#2 Grease	
	Coupling	SHELL ALVANIA EP #2 Grease	
	Battery	Distilled water	
6	AIR COMPRESSOR/ PNEUMATIC SYSTEM	Oil CHEMLUBE 5103	2275143/1
		Air intake filter cartridge	U11921
		Motor Brushes	(TBS)
		Desiccant Charge	503329
		O-Ring Grease	Dow Corning Lubricant 55
7	COUPLER	Filter kit	13-62766
		AGIP AUTOL 2000 Grease	
		CRC Contact Cleaner 2000	
		JET-LUBE 769 LUBRICANT	
8	DOORS and STEPS	Molykote 44	67110233
		Berutox FB-22 Grease	67110240-01
		Berutox MB2-H	67110240
		Berutox M21EPK420	
		Exxon Beacon-325 (EP 2) Grease	
		Loctite 38050	
		Loctite 542	
		Modified Cyanoacrilate Adhesive	

Table 11-1.24 Running Maintenance - List of Consumable Materials (Cont'd)

SECT	SYSTEM/ASSY	DESCRIPTION	P/N
9	HVAC UNITS	Fresh air Filter (Sutrak) Return air filter (BCF)	524.162.29 R07634535
10	LIGHTING	Fluorescent lamps 48" Fluorescent lamps 36" Bulb lamps	R0748180013 R0748180014 AM-4037-1
11	COMMUNICATION	NOT APPLICABLE	
12	DESTINATION SIGN	Bulb lamps Bulb lamps Bulb lamps	AD-362-18 AD-362-46 AD-362-23
13	UNASSIGNED		
14	UNASSIGNED		
15	PANTOGRAPH	Carbon contact strips Carbon spacers SHELL Alvania 2 grease CRC Contact cleaner 2000	863106 863105 863709
16	BRAKES	Brake pad Brake pad LUBER-STABURAGS NBU 30 PTM	U14382/1 U14382/2
	Calipers	Grease	AERO SHELL #6
	Pneumatic Components (Cocks, Valves, etc)	Grease	AERO SHELL #6

11-1.26 Heavy Maintenance - List of Consumable Materials

Table 11-1.25 lists the Consumable Materials required to perform the Heavy - PM Tasks listed in the PM Matrix (System Based/Mileage Based).

Table 11-1.25 Heavy Maintenance - List of Consumable Materials

Sect.	System/Assy	Description	Identification
2	CAR BODY		
	Car Body Connection	LUBRICANT	JET LUBE 769
	Floor Trap	Adhesive Tape	3M 950 type Transfer
3	TRUCK		
	Journal Bearing	Grease	SHELL ALVANIA #2
	Slewing Ring	Grease Cleaning Solvent	MOLYKOTE LONG TERM 2 MIROBO A151 Kaltryn KEV
	Secondary Suspension	Conductor Terminal Compound	(commercial)
	Transom Joint	Light Machine Oil	SAE 30
	Wheel Rubber Blocks	Water/oil soap	Murphy's Concentrate oil Soap (gel)
	Odometer	Sealant	LOCTITE 242
	Labels	Two-component adhesive	S.I.P.A.L AREXON Cod. 4565
	AIR SUSPENSION Air Filter Overflow Valve Leveling Valve Duplex Check Valve Test Fitting	Brake Cylinder Lubricant	AERO SHELL #6
	Air Reservoir	Thread Sealant	Teflon (liquid or tape)

Table 11-1.25 Heavy Maintenance - List of Consumable Materials (Cont'd)

Sect.	System/Assy	Description	Identification
4	PROPULSION		
	Electrical Equipment	Cement	C&B Rubber CB1000
		Sealant	HUBBS & HOME Permatex #3
		Scotch Brite	# 2774
		Contact Oil	SF1154
	Traction Motor	Grease	D6A2C5
		Fiber Glass Tape	41D735660P7
		Air Dry Varnish	41A239176P487
		Grease	D50E17
	Gear Unit	Lubricant	SHELL HD 80W90
		Sealant	SILMATE HUBBS & HOME Permatex #14
	Coupling	Grease	SHELL ALVANIA #2 SHELL ALVANIA EP # 2
5	HV/LV	Not Applicable	
6	Air Compressor	Synthetic Lubricant Oil	Type 1536 Curil N Loctite 242 Primer N
		Sealant	Loctite 222 Loctite 274
	Twin Tower Air Dryer	Grease (Brake Cylinder Lubricant)	AERO SHELL #6
		Desiccant Charge	503329
	Cut Out Cock	Grease (Brake Cylinder Lubricant)	AERO SHELL #6
	Magnet Valve		
	Test Fitting		
	Air Reservoir Pneumatic Horn	Thread Sealant	Teflon (liquid or tape)

Table 11-1.25 Heavy Maintenance - List of Consumable Materials (Cont'd)

Sect.	System/Assy	Description	Identification
7	COUPLER	Grease	AGIP AUTOL TOP 2000
	Coupler Contacts	Contact Cleaner Scotch Brite Grease Cleaner	CRC-26 3M # 2774 Varsol
	Air Filter	Filter Kit	13-62766
	Pneumatic Uncoupling Valve	Grease (Brake Cylinder Lubricant)	AERO SHELL #6
8	DOORS		
	Roller Cariage Motor Braket	Lubricant	Berutox FB-22 Berutox MB2-H
	Electromotor and Gear Box Assy	Lubricant	Berutox FB-22 Berutox MB2-H Berutox M21EPK420
	Window Glass Channel	Lubricant	Slip-Ease
	Door Panel Assy	Sealant	Loctite 222
	Eckart Mechanism	Grease Sealant	Exxon Beacon EP2 Loctite 542
	STEPS	Adhesive	P/N 67110007-01
9	AIR COMFORT		
	HVAC	Freon 22	
	Motor Compressor Unit	Refrigerant oil	EXXON ZERICE FUCHS REVISO MOBIL KMOIL F MOBIL EAL ARTIC 68 SUNOCO SUNISD 54S
		Contact cleaner	CRC-26
	Fiberglass Housing	Gel Coat	Charcoal Gray
10	LIGHTING	Not Applicable	
11	COMMUNICATION	Not Applicable	

Table 11-1.25 Heavy Maintenance - List of Consumable Materials (Cont'd)

Sect.	System/Assy	Description	Identification
12	DESTINATION SIGN	Not Applicable	
13	Unassigned		
14	Unassigned		
15	PANTOGRAPH	Grease Contact Cleaner Carbon Contact Strips Carbon Spacers	SHELL ALVANIA # 2 CRC 2000 863106/863105 863709
16	BRAKES Air Reservoir	Thread Sealant	Teflon (liquid or tape)
	Pneumatic Component (Cocks, Valves etc.)	Grease (Brake Cylinder Lubricant)	AERO SHELL #6
	Brake Caliper	Grease Solvent Adhesive (Silicone) Sealant Brake Pad	AERO SHELL #6 Varsol RTV P/N 2275002 Loctite 242 U14382/1 U14382/2
	Brake Disk	Grease	Molykote paste G

11-1.27 MUNI Cleaning Products

For MUNI Cleaning Products refer to the following Table 11-1.26.

Table 11-1.26 MUNI Cleaning Products List

Assy	Product	Use	NOTE
Exterior	MC 850 Gel Graffiti Remover	To remove graffiti from not printed surfaces	CAUTION: Wear gloves and safety goggles
Interior	MC 850 Gel Graffiti Remover	To remove graffiti from not printed surfaces	CAUTION: Wear gloves and safety goggles
Exterior	Premier Bus Wash "299"	To wash LRV exterior	
Floor	Bleach	To remove hard dirt.	WARNING: Exposure to heat and light will accelerate Bleach decomposition. Mixing with other chemicals products may cause chemical reaction with liberation of hazardous gases. NOTE: It is recommended lemon Bleach
Interior	Green Devil	To clean interior of LRV	
Windows Windshield Door's Windows	Blue Sky	To clean and degrease glass surfaces	
Air Reservoir	Aqua Works cold cleaning solution	To clean Air Reservoir (interior)	CAUTION: Wear gloves and safety goggles

Table 11-1.26 MUNI Cleaning Products List (cont'd)

Assy	Product	Use	NOTE
Miscellanea	Safety Kleen Premium Solvent	To clean and degrease any metal parts	CAUTION: Wear gloves and safety goggles. Dangerous if inhalated.
Metallic parts not painted	Degreasing solvent: 1. VM&P Naptha 2. White Kerosene 3. White Gasoline 4. Petroleum ether 5. #1 denatured alcohol 6. # 30 denatured alcohol 7. Isobuthyl alcohol 8. Isopropyl alcohol 9. Varsol.	To degrease parts.	CAUTION: Wear rubber gloves and safety goggles.
HVAC	KON TROLE CONDENSATE DRAIN PAN Cleaner	To clean HVAC drainage piping	CAUTION: Wear gloves and safety goggles.
Main Inverter Group	DAWN (Dishwasher)	To clean Weldment Group Exterior	
Aux Power Group	DAWN (Dishwasher)	To clean Weldment Group Exterior	
Electrical Contacts	CRC 2-26.	Contact Cleaner.	CAUTION: Wear gloves and safety goggles. Dangerous if inhalated.

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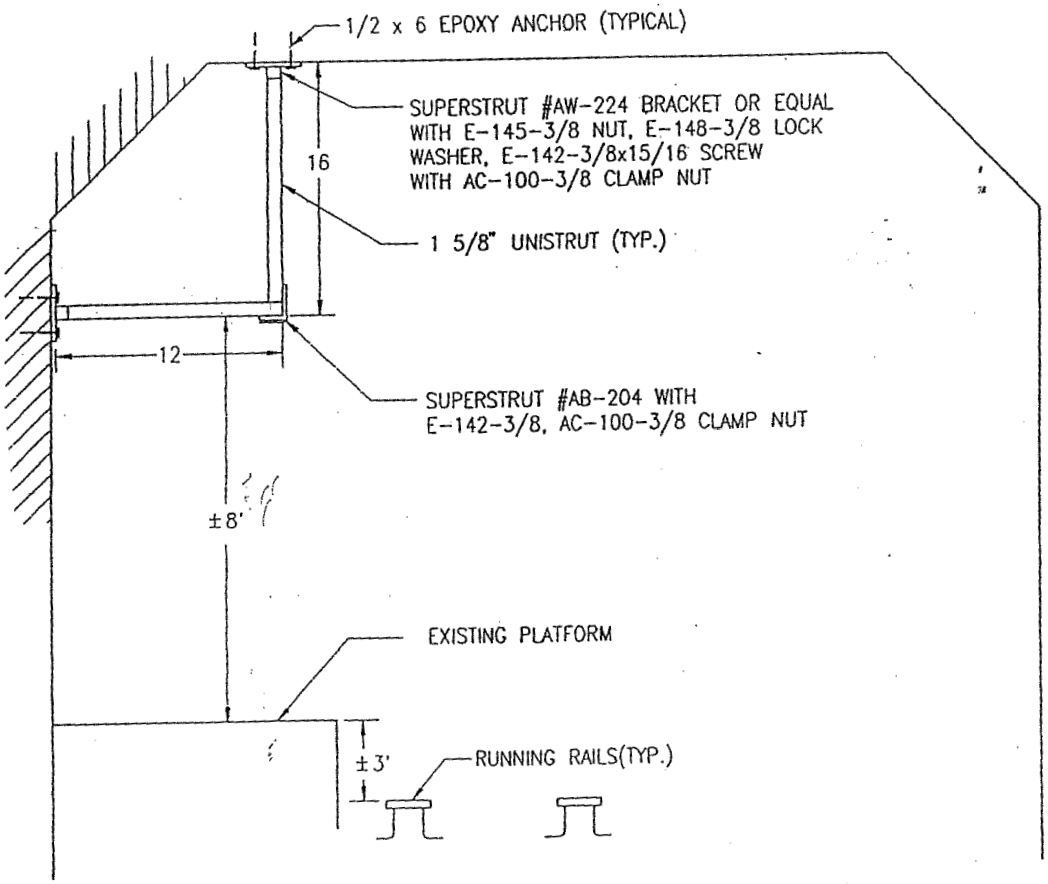
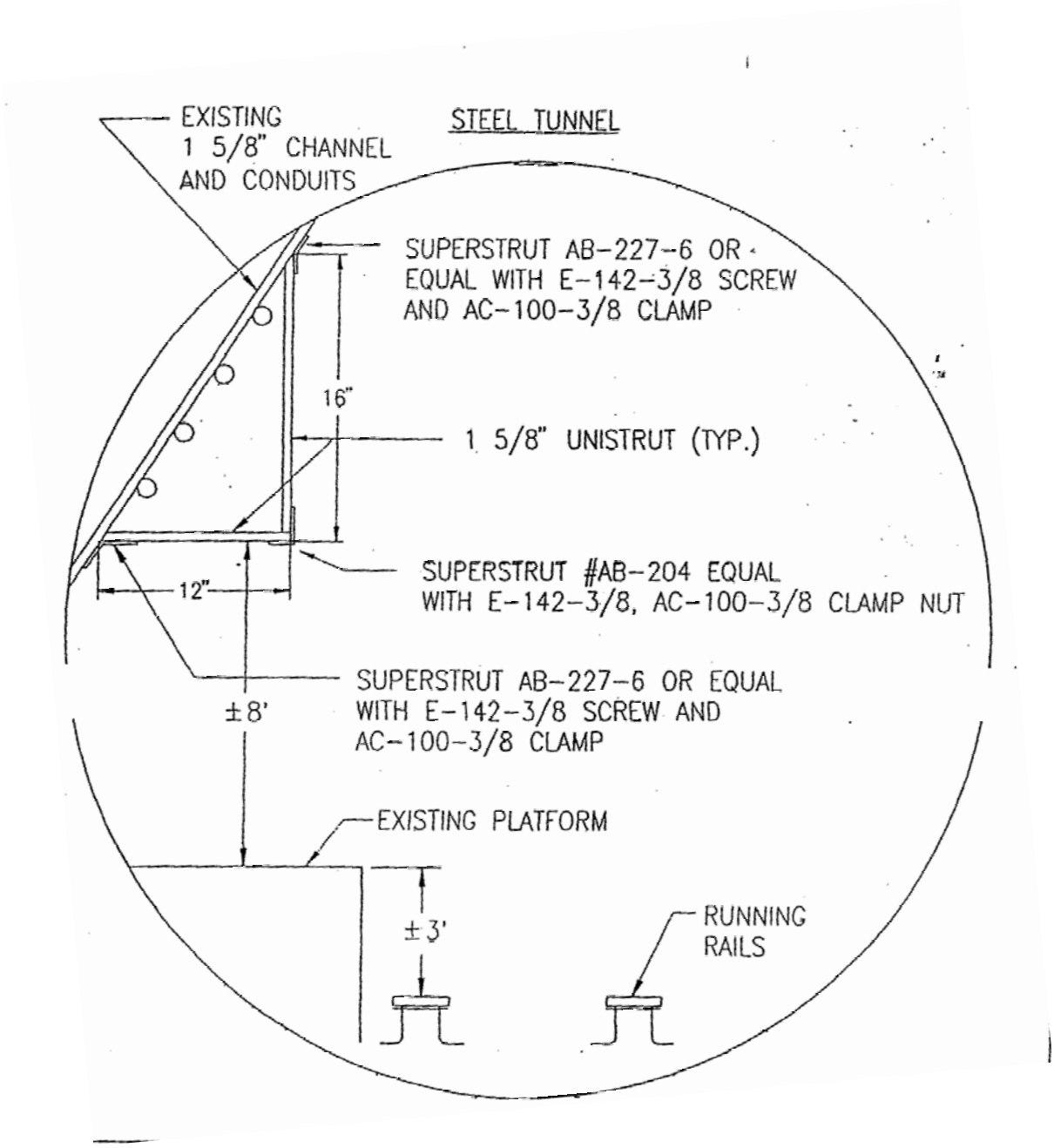
appendix **thirty**

Underground Tunnel Clearance Diagrams

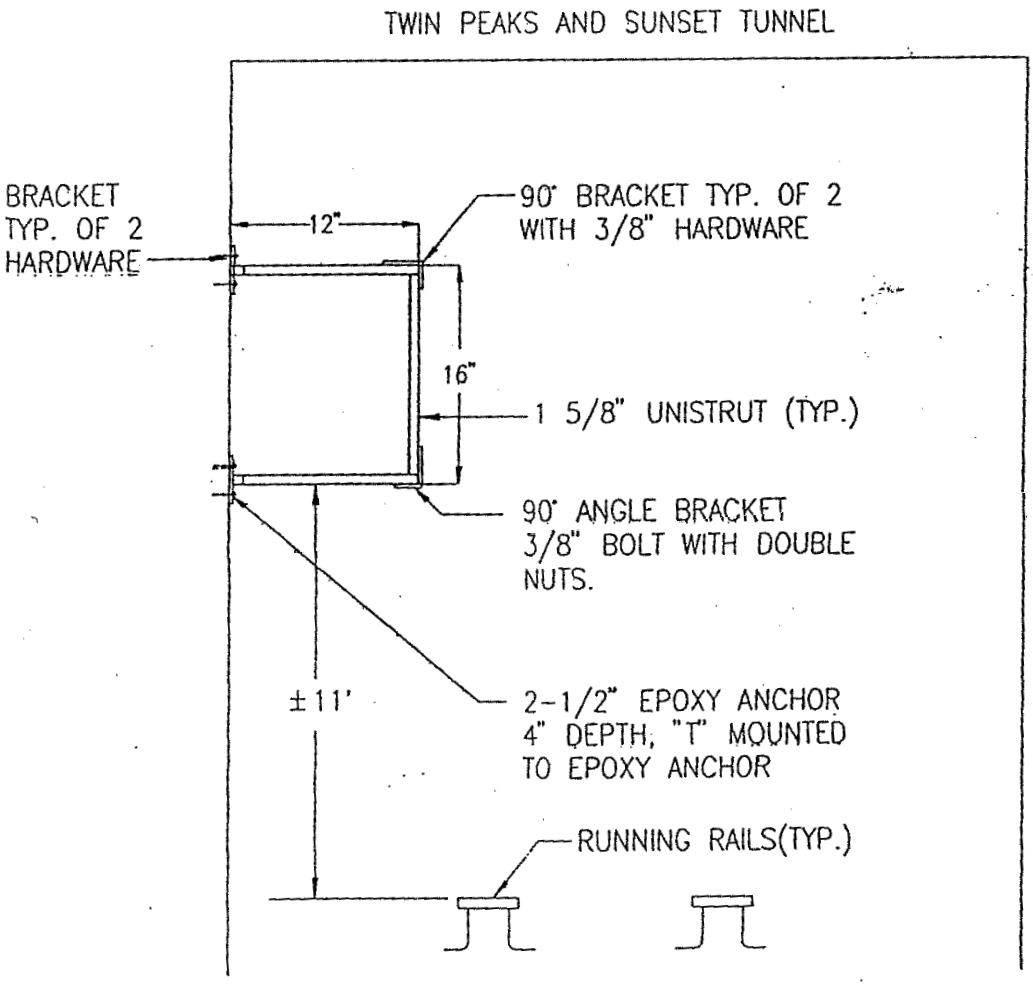
for reference only


1/2 x 6 EPOXY ANCHOR (TYPICAL)
SUPERSTRUT #AW-224 BRACKET OR EQUAL WITH E-145-3/8 NUT, E-148-3/8 LOCK WASHER, E-142-3/8x15/16 SCREW WITH AC-100-3/8 CLAMP NUT
16
1 5/8" UNISTRUT (TYP.)
12
SUPERSTRUT #AB-204 WITH E-142-3/8, AC-100-3/8 CLAMP NUT
±8'
EXISTING PLATFORM
±3'
RUNNING RAILS(TYP.)

Clearance Diagram - Typical Concrete Tunnel



Clearance Diagram - Steel Tunnel


TWIN PEAKS AND SUNSET TUNNEL
BRACKET TYP. OF 2 HARDWARE
12"
90° BRACKET TYP. OF 2 WITH 3/8" HARDWARE
16"
1 5/8" UNISTRUT (TYP.)
90° ANGLE BRACKET 3/8" BOLT WITH DOUBLE NUTS.
±11'
2-1/2" EPOXY ANCHOR 4" DEPTH, "T" MOUNTED TO EPOXY ANCHOR
RUNNING RAILS(TYP.)

Clearance Diagram – Twin Peaks Tunnel

appendix **thirty-one**

SFMTA Surface Stop Shelters with NextBus Displays

for reference only

SFMTA Surface Stop Shelter List (June 5, 2008)

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1434	3008	C	02ND ST	FOLSOM ST	SW		37.78522	-122.39637
467	3011	C	02ND ST	HOWARD ST	SW		37.78642	-122.39792
492	3105	C	03RD ST	22ND ST	NW		37.75817	-122.38821
197	3124	C	03RD ST	FOLSOM ST	NE		37.78408	-122.39917
317	7347	NC	03RD ST	GILMAN AVE	NE	Y	37.722449	-122.39561
111	3127	C	03RD ST	HUDSON AVE	SE		37.74012	-122.3887
1445	3129	C	03RD ST	INNES AVE	SW		37.73932	-122.38926
33	3136	C	03RD ST	MARKET (Jessie)	E	Y	37.78702	-122.4029
650	3140	C	03RD ST	PALOU AVE	NE		37.733939	-122.390997
493	3144	C	03RD ST	PERRY ST	E		37.78213	-122.39672
21	3158	C	04TH ST	FOLSOM ST	SW	Y	37.78173	-122.40089
246	3159	C	04TH ST	HOWARD ST	SW	Y	37.78295	-122.40243
118	7166	C	04TH ST	KING ST	NE	Y	37.776046	-122.393692
1418	3160	C	04TH ST	MISSION ST	SW		37.78413	-122.40391
1447	3165	C	04TH ST	TOWNSEND ST	NW		37.77701	-122.394746
713	7003	C	05TH ST	MARKET ST	NE	Y	37.783992	-122.408066
714	3612	C	05TH ST	MARKET ST	NW	Y	37.78409	-122.40829
712	7309	C	05TH ST	EDDY	SW		37.784314	-122.408576
177	7214	C	05TH ST	FOLSOM ST	NE		37.78044	-122.403466
178	3168	C	05TH ST	FOLSOM ST	NW	Y	37.78031	-122.40357
266	3169	C	05TH ST	HARRISON ST	NE		37.77931	-122.40205
392	3170	C	05TH ST	HOWARD ST	SE		37.78145	-122.40475
393	3171	C	05TH ST	HOWARD ST	SW		37.78123	-122.40474
341	3173	C	05TH ST	MISSION ST	NW	Y	37.78277	-122.40665
744	3178	C	06TH AVE	BALBOA ST	SE		37.77692	-122.46404
1017	3180	C	06TH AVE	CLEMENT ST	NE		37.783216	-122.464382
342	3181	C	06TH AVE	CLEMENT ST	NW		37.78309	-122.46448

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1330	3182	C	06TH AVE	CORNWALL ST	SW		37.784673	-122.46448
1018	3184	C	06TH AVE	GEARY BLVD	SE		37.78079	-122.46418
53	3185	C	06TH AVE	GEARY BLVD	SW		37.78065	-122.46431
571	3201	C	08TH AVE	FULTON ST	NE		37.77373	-122.46585
572	3202	C	08TH AVE	FULTON ST	NW		37.77353	-122.46594
1196	3209	C	08TH ST	MARKET ST	SW	Y	37.77839	-122.41447
1197	3208	C	08TH ST	MISSION ST	SW		37.77719	-122.41296
1366	3213	C	09TH AVE	IRVING ST	NE	Y	37.76382	-122.46637
83	3212	C	09TH AVE	IRVING ST	SE	Y	37.763888	-122.466245
394	3214	C	09TH AVE	JUDAH ST	SE		37.76202	-122.4661
395	3215	C	09TH AVE	JUDAH ST	SW		37.762066	-122.466275
1019	3216	C	09TH AVE	KIRKHAM ST	NW	Y	37.76048	-122.46611
1020	3217	C	09TH AVE	KIRKHAM ST	SE		37.76018	-122.46598
1052	3218	NC	09TH AVE	LAWTON ST	NW	Y	37.75859	-122.46599
146	3221	C	09TH AVE	LINCOLN WAY	SW		37.76563	-122.46648
147	3220	C	09TH AVE	LINCOLN WAY	SE		37.76579	-122.46638
1158	3223	C	09TH AVE	MORAGA ST	SE	Y	37.75646	-122.46572
573	3236	C	11TH ST	FOLSOM ST	NE		37.77212	-122.41422
574	3237	C	11TH ST	FOLSOM ST	SW		37.77159	-122.41381
1223	3239	C	11TH ST	HARRISON ST	SW		37.77036	-122.41227
775	3238	NC	11TH ST	HARRISON ST	NE		37.77085	-122.41263
1159	3240	C	11TH ST	HOWARD ST	NE		37.77333	-122.41573
1505	3241	C	11TH ST	HOWARD ST	SW		37.77283	-122.41538
1448	3243	C	11TH ST	MISSION (Minna)	NW		37.774038	-122.416891
678	3248	NC	14TH AVE	SANTIAGO ST	SE		37.74503	-122.4703
1534	3255	C	14TH ST	CHURCH ST	SW		37.76767	-122.42913
290	3266	C	15TH AVE	TARAVAL ST	SE	Y	37.743124	-122.471297
291	3267	C	15TH AVE	TARAVAL ST	SW	Y	37.743069	-122.471405
292	3282	C	16TH ST	BRYANT ST	SE	Y	37.76553	-122.410386
94	3281	C	16TH ST	BRYANT ST	NE	Y	37.76569	-122.410349
396	3285	NC	16TH ST	DOLORES ST	SW	Y	37.764575	-122.426579

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
877	3284	C	16TH ST	DOLORES ST	NE	Y	37.764731	-122.426156
878	3288	C	16TH ST	HARRISON ST	NE	Y	37.765523	-122.412976
343	3293	C	16TH ST	MISSION ST	SW	Y	37.764983	-122.419835
82	3291	C	16TH ST	MISSION ST	NE	Y	37.765123	-122.419498
575	3296	C	16TH ST	POTRERO AVE	SW	Y	37.765701	-122.40773
596	3295	C	16TH ST	POTRERO AVE	NW	Y	37.765825	-122.408122
1449	3299	C	16TH ST	SHOTWELL ST	NE	Y	37.765218	-122.416048
1198	3300	C	16TH ST	VALENCIA ST	NE	Y	37.764987	-122.421746
544	3301	C	16TH ST	VALENCIA ST	SW	Y	37.764849	-122.422056
1419	3311	K	17TH ST	CASTRO ST			37.789378	-122.396961
1087	3304	NC	17TH AVE	RIVERA ST	NW		37.74698	-122.47391
1199	3305	NC	17TH AVE	RIVERA ST	SE		37.74675	-122.47373
1450	3312	C	17TH ST	DE HARO ST	NE	Y	37.764904	-122.401451
1419	3311	NC	17TH ST	MARKET ST (Castro)	E		37.76252	-122.434866
517	3325	C	18TH ST	CASTRO ST	NW	Y	37.76091	-122.43551
518	3326	C	18TH ST	CASTRO ST	SE		37.76087	-122.43458
1200	3322	NC	18TH ST	CHURCH ST	NE	Y	37.76135	-122.4282
545	3323	NC	18TH ST	CHURCH ST	SE	Y	37.76127	-122.42795
293	3324	C	18TH ST	CONNECTICUT ST	NE	Y	37.76258	-122.397352
1367	3329	C	18TH ST	DIAMOND ST	SW		37.7607	-122.43733
880	3330	C	18TH ST	DOLORES ST	NW		37.76145	-122.42652
881	3333	C	18TH ST	GUERRERO ST	NW	Y	37.76159	-122.42415
882	3334	C	18TH ST	GUERRERO ST	SE	Y	37.76154	-122.4234
917	3339	NC	18TH ST	MARKET ST	NE		37.75982	-122.4444
1506	3343	C	18TH ST	PENNSYLVANIA AVE	SE	Y	37.762732	-122.39322
1507	3346	C	18TH ST	TEXAS ST	NE	Y	37.762701	-122.395422
198	3348	C	18TH ST	VALENCIA ST	NW	Y	37.761762	-122.421698
829	3349	C	18TH ST	VALENCIA ST	SE	Y	37.76168	-122.42122
199	385	NC	19TH AVE	CRESPI DR	SW		37.720976	-122.475107
679	835	C	19TH AVE	HOLLOWAY AVE	NE	Y	37.720976	-122.475107
1088	3359	C	19TH AVE	IRVING ST	NW	Y	37.76368	-122.47731

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1160	3360	C	19TH AVE	IRVING ST	SE	Y	37.76343	-122.47704
92	3365	C	19TH AVE	JUDAH ST	SW	Y	37.7614	-122.47711
105	3363	C	19TH AVE	JUNIPERO SERRA BLVD	NW		37.717323	-122.47297
105	7001	C	19TH AVE	JUNIPERO SERRA BLVD			37.717371	-122.472813
1658	3369	NC	19TH AVE	LAWTON ST	SW		37.757889	-122.476782
98	392	C	19TH AVE	LINCOLN WY	SE		37.765159	-122.47721
621	3383	C	19TH AVE	QUINTARA ST	SE	Y	37.74853	-122.4759
622	3384	C	19TH AVE	QUINTARA ST	SW	Y	37.7483	-122.47614
294	3394	C	19TH AVE	TARAVAL ST	NE	Y	37.74331	-122.47554
99	3395	C	19TH AVE	TARAVAL ST	NW	Y	37.74318	-122.47578
623	3398	C	19TH AVE	VICENTE ST	SE	Y	37.7392	-122.47528
652	3399	C	19TH AVE	VICENTE ST	SW	Y	37.73901	-122.47553
653	3403	C	19TH AVE	WINSTON DR	NW	Y	37.72726	-122.47511
681	3402	C	19TH AVE	WINSTON DR	NE	Y	37.72719	-122.47468
576	3410	NC	20TH ST	03RD ST (Tennessee)	NE		37.760528	-122.38936
1202	3420	NC	20TH ST	MISSOURI ST	NE		37.75999	-122.39643
247	3425	C	22ND AVE	IRVING ST	NE	Y	37.76374	-122.4803
597	3426	NC	22ND AVE	JUDAH ST	SE	Y	37.76144	-122.48016
624	3441	C	23RD AVE	IRVING ST	SW		37.76307	-122.48145
1203	3446	NC	23RD AVE	MORAGA ST	NW	Y	37.756	-122.48095
179	3453	NC	23RD ST	UTAH ST	NE		37.75442	-122.40494
682	3454	NC	23RD ST	UTAH ST	SE		37.75431	-122.40514
1161	3456	C	23RD ST	VERMONT ST	SW		37.7544	-122.40367
683	3455	NC	23RD ST	VERMONT ST	NW		37.75448	-122.40391
684	3458	C	24TH ST	BRYANT ST	NW	Y	37.75283	-122.40947
685	3459	C	24TH ST	BRYANT ST	SE	Y	37.75278	-122.40878
469	3463	C	24TH ST	CASTRO ST	SE	Y	37.75127	-122.43375
397	3460	C	24TH ST	CHURCH ST	NE	Y	37.75174	-122.42729
398	3461	C	24TH ST	CHURCH ST	SW	Y	37.75164	-122.42759
470	3465	C	24TH ST	DIAMOND ST	SW	Y	37.7511	-122.43645
217	3466	NC	24TH ST	DOLORES ST	NW	Y	37.75185	-122.42559

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1453	3470	C	24TH ST	FOLSOM ST	SE	Y	37.75248	-122.41369
416	3469	C	24TH ST	FOLSOM ST	NW	Y	37.75253	-122.41442
365	3472	NC	24TH ST	GUERRERO ST	SW		37.75192	-122.42303
344	3476	C	24TH ST	MISSION ST	NE		37.75229	-122.41828
345	3477	C	24TH ST	MISSION ST	SW	y?	37.7522	-122.41861
778	3486	C	24TH ST	VALENCIA ST	SE	Y	37.7521	-122.42019
218	3489	NC	25TH AVE	BALBOA ST	NW	Y	37.77641	-122.48453
295	3491	NC	25TH AVE	CALIFORNIA ST	NW	Y	37.784	-122.48509
745	3495	C	25TH AVE	CLEMENT ST	NW	Y	37.78214	-122.48496
627	3499	NC	25TH AVE	FULTON ST	SE		37.77269	-122.48428
296	3501	C	25TH AVE	GEARY BLVD	SE	Y	37.780015	-122.484562
60	3500	C	25TH AVE	GEARY BLVD	NW	Y	37.780166	-122.484768
1123	3511	NC	25TH ST	HAMPSHIRE (Potrero)	NE		37.75143	-122.406635
1275	3520	NC	26TH ST	NOE ST	NW		37.74827	-122.43177
1276	3521	NC	26TH ST	NOE ST	SW		37.74816	-122.43181
494	3540	C	30TH ST	MISSION ST	NW		37.7424	-122.42238
918	3541	C	30TH ST	MISSION ST	SW		37.74231	-122.42217
546	3545	NC	32ND AVE	BALBOA ST	N		37.77668	-122.49195
519	3549	C	32ND AVE	CLEMENT ST	NE		37.781802	-122.492425
1308	3552	NC	33RD AVE	ANZA ST	SE	Y	37.77761	-122.49308
1226	3555	C	33RD AVE	CLEMENT ST	SE	Y	37.7815	-122.49337
1332	3560	C	33RD AVE	GEARY BLVD	SE		37.77933	-122.49333
947	3558	C	33RD AVE	GEARY BLVD	NW		37.77988	-122.49337
948	3559	C	33RD AVE	GEARY BLVD	SW		37.77953	-122.49323
1277	3561	NC	36TH AVE	LINCOLN WAY	SE		37.76448	-122.49539
1387	3564	NC	39TH AVE	RIVERA ST	NE		37.74613	-122.49735
1333	3570	NC	45TH AVE	BALBOA ST	SE		37.77517	-122.50586
1204	3574	NC	46TH AVE	IRVING ST	NW		37.7624	-122.5061
780	3576	C	46TH AVE	JUDAH ST	NW	Y	37.76054	-122.50598
781	3577	C	46TH AVE	JUDAH ST	SE	Y	37.76029	-122.50587
1205	3583	NC	46TH AVE	LINCOLN WAY	SW		37.76396	-122.50622

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
782	3586	C	46TH AVE	NORIEGA ST	SE		37.75279	-122.50533
887	3587	C	46TH AVE	NORIEGA ST	SW		37.75274	-122.50541
1206	3596	NC	46TH AVE	SANTIAGO ST	NW		37.74378	-122.50482
1346	3598	NC	46TH AVE	TARAVAL ST	NW	Y	37.7419	-122.50468
366	3599	NC	46TH AVE	TARAVAL ST	SE	Y	37.741654	-122.50458
625	3607	NC	48TH AVE	PT. LOBOS AVE (Geary)	NW		37.77991	-122.50994
598	3622	C	ALEMANY BLVD	WORCHESTER (Arch)	SW		37.711418	-122.46717
746	3636	NC	ARBALLO DR	ACEVEDO AVE	NW		37.720091	-122.48309
1536	3650	C	ARGUELLO BLVD	GEARY BLVD	SE	Y	37.78108	-122.45877
577	3649	C	ARGUELLO BLVD	GEARY BLVD	NW	Y	37.78145	-122.45897
845	3661	C	ASHBURY ST	FREDERICK ST	SE		37.76713	-122.44629
578	3681	NC	AVALON AVE	LA GRANDE AVE	SW		37.72474	-122.42437
1207	3687	NC	BACON ST	GOETTINGEN ST	NE		37.72691	-122.40648
810	3019	C	BACON ST	SAN BRUNO AVE	SE		37.72772	-122.4031
982	3033	C	BALBOA ST	04TH AVE	SW		37.77726	-122.46199
1454	3035	C	BALBOA ST	06TH AVE	SE		37.77718	-122.46363
182	3034	C	BALBOA ST	06TH AVE	NW		37.77728	-122.46435
1054	3038	NC	BALBOA ST	10TH AVE	NE		37.77708	-122.46815
847	3044	C	BALBOA ST	17TH AVE	SW		37.77662	-122.47602
1022	3045	C	BALBOA ST	19TH AVE	NE		37.77666	-122.47791
1023	3046	C	BALBOA ST	19TH AVE	SW		37.77653	-122.47816
1055	3048	NC	BALBOA ST	21ST AVE	SW		37.77644	-122.4803
1368	3047	C	BALBOA ST	21ST AVE	NE		37.77656	-122.48005
1227	3050	NC	BALBOA ST	23RD AVE	SW		37.77634	-122.48246
1309	3051	NC	BALBOA ST	25TH AVE	NW	Y	37.77634	-122.48481
157	3052	NC	BALBOA ST	25TH AVE	SE	Y	37.77625	-122.4841
1280	3053	C	BALBOA ST	28TH AVE	NE		37.77622	-122.48754
1228	3056	NC	BALBOA ST	30TH AVE	SW		37.776	-122.48995
548	3055	NC	BALBOA ST	30TH AVE	NW		37.7761	-122.4901
123	3058	NC	BALBOA ST	32ND AVE	SW		37.7759	-122.49209
1056	3064	NC	BALBOA ST	40TH AVE	SW		37.7755	-122.50065

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
983	3067	C	BALBOA ST	ARGUELLO BLVD	NW		37.77747	-122.45886
747	3070	NC	BALBOA ST	PARK PRESIDIO BLVD	NW	Y	37.77692	-122.47246
748	3071	NC	BALBOA ST	PARK PRESIDIO BLVD	SW	Y	37.77678	-122.47226
1090	3025	C	BATTERY ST	BROADWAY	SW	Y	37.79848	-122.401151
1091	3030	C	BATTERY ST	JACKSON ST	NW	Y	37.79686	-122.40077
132	3772	C	BAYSHORE BLVD	ARLETA AVE	SW	Y	37.71215	-122.4031
603	7334	C	BAYSHORE BLVD	BLANKEN AVE	SE		37.71208	-122.402534
1133	3775	C	BAYSHORE BLVD	BOUTWELL ST	NE		37.73488	-122.40588
22	3779	C	BAYSHORE BLVD	CORTLAND AVE	NW	Y	37.73967	-122.40712
749	3778	C	BAYSHORE BLVD	CORTLAND AVE	NE	Y	37.73986	-122.40677
1092	3784	C	BAYSHORE BLVD	MARENGO ST	NE		37.73877	-122.40689
1508	3786	C	BAYSHORE BLVD	OAKDALE AVE	SE		37.74288	-122.40519
890	3777	C	BAYSHORE BLVD	QUINT (Carroll)	NE		37.73028	-122.40313
1024	3788	C	BAYSHORE BLVD	SILVER AVE	NE		37.70909	-122.40485
319	3793	C	BAYSHORE BLVD	VISITACION AVE	NE		37.71062	-122.40389
750	3092	C	BEACH ST	MASON ST	SW	Y	37.807407	-122.414125
1347	3093	C	BEACH ST	POLK ST	NE		37.80634	-122.42333
751	3095	C	BEACH ST	STOCKTON ST	SW	Y	37.807841	-122.41081
715	3089	C	BEALE ST	MISSION ST	S		37.79175	-122.3967
738	3696	C	BOSWORTH ST	DIAMOND ST	SE	Y	37.733354	-122.433232
1348	3697	NC	BOSWORTH ST	ELK ST	NW		37.73496	-122.44017
1093	3765	NC	BRAZIL AVE	NAPLES ST	NE	Y	37.72238	-122.4299
520	3718	NC	BROAD ST	PLYMOUTH AVE	SE		37.713222	-122.455927
520A	3719	NC	BROAD ST	PLYMOUTH AVE	NW		37.713161	-122.45618
802	3084	C	BROADWAY	MONTGOMERY ST	SW		37.79813	-122.40406
783	3730	C	BRYANT ST	16TH ST	SE		37.76549	-122.4104
1455	3732	C	BRYANT ST	17TH ST	SE		37.76422	-122.41028
1456	3733	C	BRYANT ST	17TH ST	SW		37.76402	-122.41041
1509	3735	C	BRYANT ST	18TH ST	SE		37.76167	-122.41004
1510	3734	C	BRYANT ST	18TH ST	NW		37.76187	-122.4102
1511	3737	C	BRYANT ST	19TH ST	SE		37.76038	-122.40991

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
813	3742	C	BRYANT ST	22ND ST	NE	Y	37.75621	-122.40942
687	3746	C	BRYANT ST	24TH ST	NE	Y	37.75306	-122.40907
1457	3752	C	BRYANT ST	ALAMEDA ST	NE		37.76845	-122.41068
1421	3812	C	BUSH ST	HYDE ST	SE		37.78915	-122.41658
267	3814	C	BUSH ST	LEAVENWORTH ST	SE		37.7893	-122.41496
50	7204	C	CABRILLO ST	LA PLAYA ST	SE		37.773206	-122.509876
920	3823	C	CALIFORNIA ST	04TH AVE	SW	Y	37.785178	-122.46257
367	3824	C	CALIFORNIA ST	06TH AVE	NW	Y	37.785017	-122.464939
219	3826	C	CALIFORNIA ST	07TH-6TH AVE	SE	Y	37.78488	-122.4652
1369	3832	C	CALIFORNIA ST	12TH AVE	SW		37.784454	-122.471103
1282	3835	C	CALIFORNIA ST	19TH AVE	NE		37.784241	-122.478446
922	3836	C	CALIFORNIA ST	19TH AVE	SW		37.784109	-122.47871
924	3840	C	CALIFORNIA ST	25TH AVE	SW	Y	37.783808	-122.485286
949	3842	NC	CALIFORNIA ST	28TH AVE	SW		37.783658	-122.488456
1284	3844	NC	CALIFORNIA ST	30TH AVE	SE		37.783578	-122.490087
115	3853	C	CALIFORNIA ST	COMMONWEALTH ST (Cherry)	SE		37.78597	-122.456329
200	3859	C	CALIFORNIA ST	DIVISADERO ST	SW	Y	37.787954	-122.440721
268	3858	C	CALIFORNIA ST	DIVISADERO ST	NW	Y	37.788087	-122.44087
201	3866	C	CALIFORNIA ST	GRANT AVE	SE		37.79242	-122.40592
849	3868	C	CALIFORNIA ST	HYDE ST	SW		37.79096	-122.41735
804	3872	C	CALIFORNIA ST	KEARNY ST	SE		37.79263	-122.40413
368	3875	NC	CALIFORNIA ST	LAUREL ST	NE		37.786923	-122.449957
369	3876	C	CALIFORNIA ST	LAUREL ST	SW		37.786712	-122.45026
925	3879	C	CALIFORNIA ST	MAPLE ST	NW		37.786219	-122.45547
814	3883	C	CALIFORNIA ST	MONTGOMERY ST	SW		37.79286	-122.40298
220	3887	NC	CALIFORNIA ST	PARK PRESIDIO BLVD	SW	Y	37.784365	-122.472764
926	3886	NC	CALIFORNIA ST	PARK PRESIDIO BLVD	NW		37.784502	-122.473006
805	3890	C	CALIFORNIA ST	POWELL ST	NW		37.7921	-122.40943
752	3892	C	CALIFORNIA ST	PRESIDIO AVE	NW	Y	37.787287	-122.447177
950	3893	C	CALIFORNIA ST	PRESIDIO AVE	SW	Y	37.787146	-122.447199
400	3894	C	CALIFORNIA ST	SANSOME ST	NE		37.79313	-122.401

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
370	3897	C	CALIFORNIA ST	SPRUCE ST	SW		37.786334	-122.453517
927	3896	C	CALIFORNIA ST	SPRUCE ST	NE	Y	37.786503	-122.453281
1286	3901	NC	CALIFORNIA ST	TAYLOR ST	NE		37.79169	-122.41234
202	3903	C	CALIFORNIA ST	VAN NESS AVE	SE		37.79037	-122.42233
819	4083	NC	CAMBON DR	CASTELO ST	SE		37.71743	-122.47432
346	3911	C	CARL ST	COLE ST	SW	Y	37.765745	-122.450131
1162	4205	NC	CARMEL ST	TWIN PEAKS BLVD	SW		37.76094	-122.44677
928	4307	C	CASTRO ST	14TH ST	NE	Y	37.76761	-122.43558
929	4310	NC	CASTRO ST	15TH ST	SE	Y	37.76561	-122.43538
347	4313	C	CASTRO ST	17TH ST	SE	Y	37.76237	-122.43508
108	4315	C	CASTRO ST	18TH ST	SW	Y	37.76061	-122.43506
348	4314	C	CASTRO ST	18TH ST	SE	Y	37.76074	-122.43491
371	4323	NC	CASTRO ST	22ND ST	SE	Y	37.75441	-122.43431
891	4329	C	CASTRO ST	25TH ST	SE	Y	37.7496	-122.43383
930	4328	NC	CASTRO ST	25TH ST	NW	Y	37.74981	-122.43404
320	4330	NC	CASTRO ST	DUBOCE AVE	NW	Y	37.76918	-122.43596
321	4331	NC	CASTRO ST	DUBOCE AVE	SE	Y	37.76895	-122.43571
64	4334	C	CASTRO ST	MARKET ST	SW	Y	37.76214	-122.43519
1232	7014	NC	CENTRAL AVE	MCALLISTER ST	SW		37.77677	-122.44496
1126	3928	C	CESAR CHAVEZ ST	ALABAMA ST	NE		37.74842	-122.41043
1657	3935	C	CESAR CHAVEZ ST	BARTLETT (Mission)	NE		37.74825	-122.4183
1127	3929	C	CESAR CHAVEZ ST	BRYANT ST	NW	Y	37.74845	-122.40909
1128	3930	C	CESAR CHAVEZ ST	FLORIDA ST	SW		37.74823	-122.40976
547	3932	C	CESAR CHAVEZ ST	FOLSOM ST	SW		37.74815	-122.41382
1129	3933	C	CESAR CHAVEZ ST	HARRISON ST	NW	Y	37.7484	-122.4119
1130	3934	C	CESAR CHAVEZ ST	HARRISON ST	NE	Y	37.7482	-122.41163
521	3941	C	CHESTNUT ST	FILLMORE ST	NE	Y	37.80089	-122.43608
1476	3943	NC	CHESTNUT ST	FRANKLIN ST	NW		37.80208	-122.42676
322	3947	NC	CHESTNUT ST	LAGUNA ST	NW	Y	37.80145	-122.43168
1028	3951	C	CHESTNUT ST	OCTAVIA ST	SE		37.80165	-122.42928
1135	3953	C	CHESTNUT ST	PIERCE ST	SE	Y	37.80039	-122.43917

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1370	3952	C	CHESTNUT ST	PIERCE ST	NW		37.80042	-122.43981
1512	3954	C	CHESTNUT ST	SCOTT ST	NE		37.80026	-122.44105
522	3955	C	CHESTNUT ST	SCOTT ST	SW		37.80012	-122.44129
1478	3957	C	CHESTNUT ST	VAN NESS AVE	SW	Y	37.8022	-122.42494
0892A	4008	K	CHURCH ST	14TH ST	NW	Y	37.767821	-122.429065
892	7316	NC	CHURCH ST	14TH ST	NW		37.767786	-122.428996
1388	3985	I	CHURCH ST	16TH ST	NE		37.764382	-122.428609
1433	6213	NC	CHURCH ST	18TH ST	SE	Y	37.761087	-122.428136
160	6215	NC	CHURCH ST	20TH ST	NE	Y	37.758229	-122.427795
1524	3995	NC	CHURCH ST	24TH ST	NW		37.7518	-122.427497
523	3998	C	CHURCH ST	27TH ST	SE	Y	37.746809	-122.42687
1525	3999	NC	CHURCH ST	29TH ST	SE		37.743597	-122.426616
1526	4004	NC	CHURCH ST	DAY ST	SW		37.742571	-122.426609
95	7074	C	CHURCH ST	DUBOCE AVE	SE	Y	37.76932	-122.42903
1389	4010	I	CHURCH ST	MARKET ST	SE		37.76729	-122.428889
1137	4013	C	CIRCULAR AVE	MONTEREY BLVD	NW		37.73139	-122.43716
931	4016	C	CLAY ST	FRANKLIN ST	SW		37.791907	-122.424463
1209	4025	C	CLAY ST	MONTGOMERY ST	SE	Y	37.794682	-122.40277
52	4026	C	CLAY ST	POLK ST	SE		37.792385	-122.420714
1479	4027	C	CLAY ST	POWELL ST	SW	Y	37.79379	-122.409774
221	4031	C	CLAY ST	VAN NESS AVE	SW	Y	37.792106	-122.422913
473	4076	NC	CLAYTON ST	CORBETT AVE	SE	Y	37.7586	-122.4457
85	4043	C	CLEMENT ST	06TH AVE	SE		37.782865	-122.464331
298	4044	C	CLEMENT ST	08TH AVE	SE		37.782798	-122.466158
1095	4046	C	CLEMENT ST	10TH AVE	SE		37.7827	-122.46837
984	4045	C	CLEMENT ST	10TH AVE	NW		37.7828	-122.469
985	4047	C	CLEMENT ST	12TH AVE	NW		37.7827	-122.47116
1058	4049	NC	CLEMENT ST	14TH AVE	SW		37.78249	-122.47312
1537	4051	NC	CLEMENT ST	16TH AVE	SW		37.78239	-122.47536
1310	4054	C	CLEMENT ST	20TH AVE	NW		37.78231	-122.47984
1459	4056	C	CLEMENT ST	22ND AVE	NE		37.78224	-122.48152

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
579	4057	C	CLEMENT ST	22ND AVE	SW		37.78209	-122.48178
299	4060	C	CLEMENT ST	25TH AVE	SE		37.78197	-122.4845
986	4058	C	CLEMENT ST	29TH AVE	NE		37.78213	-122.48367
987	4064	NC	CLEMENT ST	29TH AVE	SW		37.78175	-122.48929
988	4066	NC	CLEMENT ST	31ST AVE	SW		37.78166	-122.49143
951	4068	C	CLEMENT ST	32ND AVE	SW		37.7816	-122.49253
1654		NC	CLEMENT ST	43RD AVE	NW		37.465236	-122.301393
372	4071	NC	CLIPPER ST	DIAMOND HEIGHTS BLVD	N		37.74689	-122.44396
700	7197	NC	CLIPPER ST	PORTOLA DR	SW		37.746837	-122.444915
222	4091	C	COLE ST	CARL ST	NE	Y	37.76604	-122.44995
626	4092	C	COLE ST	CARL ST	SW	Y	37.76556	-122.44996
753	4100	NC	COLUMBUS AVE	BAY ST	W	Y	37.80551	-122.41784
1371	4106	C	COLUMBUS AVE	FRANCISCO ST	NE		37.80458	-122.41622
1096	4115	C	COLUMBUS AVE	MASON ST	NE	Y	37.80222	-122.41281
1373	6751	C	COLUMBUS AVE	UNION ST	W	Y	37.800224	-122.410242
45	4771	NC	CONCOURSE DR	ACAD OF SCI	N		37.76995	-122.46686
1460	4124	C	CONNECTICUT ST	17TH ST	SW		37.764749	-122.397785
323	4126	C	CONNECTICUT ST	18TH ST	SE		37.76243	-122.39741
737	4169	NC	CORBETT AVE	#925 CORBETT	E		37.7521	-122.44344
893	4137	NC	CORDOVA AVE	PRAGUE ST	SE		37.71017	-122.43491
1335	4142	NC	CORTLAND AVE	ANDOVER ST	NE		37.73909	-122.41639
524	4143	C	CORTLAND AVE	ANDOVER ST	SW		37.73904	-122.41658
937	4148	C	CORTLAND AVE	BAYSHORE BLVD	SW	Y	37.73954	-122.4072
938	4154	C	CORTLAND AVE	FOLSOM ST	SW	Y	37.73892	-122.41343
133	4157	NC	CORTLAND AVE	MISSION ST	SE	Y	37.74085	-122.42251
1538	4198	NC	CRESCENT AVE	MISSION ST	NE	Y	37.73538	-122.42431
1349	4346	C	DAVIS ST	CALIFORNIA ST	NW		37.79363	-122.3977
1097	4358	NC	DE HARO ST	SOUTHERN HEIGHTS AVE	SE		37.75791	-122.40086
1564	4360	NC	DIAMOND HEIGHTS BLVD	ADDISON ST	NE		37.74044	-122.43561
443	4366	NC	DIAMOND HEIGHTS BLVD	DUNCAN ST	SE	Y	37.745239	-122.439852
605	4369	NC	DIAMOND HEIGHTS BLVD	DIAMOND ST	W	Y	37.74359	-122.43786

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
688	4368	C	DIAMOND HEIGHTS BLVD	GOLD MINE DR	NW	Y	37.74029	-122.43588
740	4367	NC	DIAMOND HEIGHTS BLVD	GOLD MINE DR	SE		37.74363	-122.43751
739	4386	C	DIAMOND ST	BOSWORTH ST	SE	Y	37.733452	-122.434068
1337	4403	NC	DIAMOND ST	SURREY ST	SE		37.73608	-122.43433
754	4411	C	DIVISADERO ST	CHESTNUT ST	NW	Y	37.80009	-122.44294
474	4414	C	DIVISADERO ST	EDDY ST	SE		37.7805	-122.43881
1312	4417	C	DIVISADERO ST	ELLIS ST	NW		37.78161	-122.43923
350	4421	C	DIVISADERO ST	GEARY BLVD	NE	Y	37.78368	-122.43945
61	4422	C	DIVISADERO ST	GEARY BLVD	SW	Y	37.78286	-122.43948
551	4424	C	DIVISADERO ST	HAIGHT ST	SW		37.77105	-122.4371
444	4433	C	DIVISADERO ST	PINE ST	SW		37.78685	-122.4403
1098	4437	C	DIVISION ST	RHODE ISLAND ST	SW		37.769804	-122.403083
719	4438	C	DIVISION ST	TOWNSEND ST (8th St)	NE		37.769849	-122.403346
816	4443	NC	DOUGLASS ST	24TH ST	NW	Y	37.75112	-122.43854
184	4455	NC	DUNCAN ST	DIAMOND HEIGHTS BLVD	SW		37.74526	-122.44029
787	4474	NC	EDDY ST	DIVISADERO ST	SE	Y	37.78059	-122.43852
1374	4476	C	EDDY ST	FILLMORE ST	SW		37.78137	-122.43244
989	4477	C	EDDY ST	GOUGH ST	NW	Y	37.78247	-122.4245
990	4478	C	EDDY ST	GOUGH ST	SW		37.78241	-122.42424
445	4484	C	EDDY ST	LAGUNA ST	NE		37.78212	-122.42728
446	4485	C	EDDY ST	LAGUNA ST	SE		37.78206	-122.42701
447	4482	C	EDDY ST	LARKIN ST	SE		37.78329	-122.41715
495	4483	C	EDDY ST	LEAVENWORTH ST	SE	Y	37.78372	-122.41395
352	4487	C	EDDY ST	PIERCE ST	NE	Y	37.78107	-122.4355
448	4488	C	EDDY ST	PIERCE ST	SW	Y	37.78095	-122.43573
373	4489	C	EDDY ST	POLK ST	NE	Y	37.78315	-122.41905
56	4490	C	EDDY ST	POLK ST	SE	Y	37.7831	-122.41877
374	4491	C	EDDY ST	VAN NESS AVE	NE	Y	37.78085	-122.43714
496	4492	C	EDDY ST	VAN NESS AVE	SE	Y	37.78074	-122.43738
203		C	ELLIS	MASON	NE			
1567	4501	C	EMBARCADERO	BAY ST	NE	Y	37.806593	-122.405594

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1568	4502	C	EMBARCADERO	BAY ST	NW	Y	37.806768	-122.40615
1575	4504		EMBARCADERO	BROADWAY	SW	Y	37.798901	-122.397434
1576	4503		EMBARCADERO	BROADWAY	NE	Y	37.799552	-122.397869
1569	4507	C	EMBARCADERO	CHESTNUT ST	SE	Y	37.80519	-122.40377
1570	7281	C	EMBARCADERO	CHESTNUT ST (Sansome)	SW	Y	37.80515	-122.403233
1573	4518		EMBARCADERO	GREEN	SW	Y	37.800605	-122.39892
1574	4517		EMBARCADERO	GREEN	NE	Y	37.801264	-122.399369
1571	4515	C	EMBARCADERO	GREENWICH	SE	Y	37.803263	-122.401113
1572	4516	C	EMBARCADERO	GREENWICH	SW	Y	37.80296	-122.401029
1577	4534		EMBARCADERO	WASHINGTON ST	SW	Y	37.796355	-122.395181
1578	4532		EMBARCADERO	WASHINGTON ST	NE	Y	37.797085	-122.39567
1289		NC	EUCLID	ARGUELLO BLVD	NE			
711	4550	C	EVANS AVE	KEITH ST	N		37.73878	-122.38076
581	4555	NC	EVANS AVE	NEWHALL ST	NE	Y	37.741905	-122.386305
580	4560	NC	EVANS AVE	PHELPS ST	E		37.74301	-122.38862
1513	4608	C	FILLMORE ST	CHESTNUT ST	N	Y	37.801091	-122.436229
223	4609	C	FILLMORE ST	CHESTNUT ST	NW	Y	37.800891	-122.436469
1351	4613	C	FILLMORE ST	GOLDEN GATE AVE	NE		37.779859	-122.431955
584	4620	C	FILLMORE ST	HAIGHT ST	SE		37.772015	-122.430531
755	4618	C	FILLMORE ST	HAIGHT ST	NW		37.772199	-122.430537
237	4621	NC	FILLMORE ST	HAYES ST	NE		37.776106	-122.431197
238	4622	NC	FILLMORE ST	HAYES ST	SW		37.775598	-122.431207
1542	4624	C	FILLMORE ST	JACKSON ST	SW		37.792219	-122.434567
324	4623	C	FILLMORE ST	JACKSON ST	NE		37.792761	-122.434556
270	4627	C	FILLMORE ST	LOMBARD ST	SW		37.799595	-122.436051
527	4628	C	FILLMORE ST	MCALLISTER ST	SE	Y	37.77854	-122.431687
528	4629	C	FILLMORE ST	MCALLISTER ST	SW	Y	37.778343	-122.431762
991	4631	C	FILLMORE ST	OAK ST	NE		37.774268	-122.430825
992	4632	C	FILLMORE ST	OAK ST	SW	Y	37.773759	-122.430866
1436	4634	C	FILLMORE ST	O'FARRELL ST	SW		37.783019	-122.432699
954	4635	C	FILLMORE ST	PINE ST	NE		37.788049	-122.433565

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
552	4637	C	FILLMORE ST	SACRAMENTO ST	NW		37.789925	-122.4341
271	4641	C	FILLMORE ST	SUTTER ST	SW	Y	37.785814	-122.433268
497	4640	C	FILLMORE ST	SUTTER ST	SE	Y	37.785994	-122.433191
607	4642	C	FILLMORE ST	TURK ST	SW		37.780204	-122.432138
993	4643	C	FILLMORE ST	UNION ST	NE	Y	37.797391	-122.435489
585	4648	NC	FITZGERALD AVE	KEITH ST	SE	Y	37.722914	-122.39483
570	4653	C	FOERSTER ST	MONTEREY BLVD	SE		37.73134	-122.44881
1437	4659	C	FOLSOM ST	05TH ST	SE		37.78045	-122.40302
1514	4660	C	FOLSOM ST	06TH ST	SE		37.77868	-122.40526
1438	4661	C	FOLSOM ST	07TH ST	SW		37.77654	-122.40798
1210	4668	C	FOLSOM ST	16TH ST	NE		37.76563	-122.41522
1461	4669	C	FOLSOM ST	16TH ST	NW		37.76543	-122.41542
1314	4671	NC	FOLSOM ST	18TH ST	SE		37.76199	-122.41491
1315	4672	NC	FOLSOM ST	18TH ST	SW		37.76192	-122.41508
818	7312	C	FOLSOM ST	24TH ST	NE	Y	37.752444	-122.414128
529	4697	NC	FOLSOM ST	PRECITA AVE	SE		37.7471	-122.41349
135	6993	NC	FOREST HILL STA	METRO TUNNEL	SW		37.74817	-122.459192
1168	4238	NC	FOWLER AVE	PORTOLA DR	SW		37.74415	-122.45298
894	4715	C	FREDERICK ST	ASHBURY ST	NW		37.76721	-122.4467
1392	4719	NC	FREDERICK ST	WILLARD ST	NW		37.76617	-122.45494
1480	4725	I	FREMONT ST	MARKET ST	SE		37.791678	-122.398116
1424	4723	C	FREMONT ST	MISSION ST	SE		37.789948	-122.395929
1291	4731	NC	FULTON ST	04TH AVE	SE		37.77384	-122.46125
1543	4732	NC	FULTON ST	06TH AVE	NW		37.77367	-122.46411
376	4733	NC	FULTON ST	06TH AVE	SE		37.77359	-122.46344
224	4734	C	FULTON ST	08TH AVE	NW		37.77347	-122.466049
67	4735	NC	FULTON ST	08TH AVE	SE		37.77333	-122.46553
1032	4737	NC	FULTON ST	10TH AVE	SE		37.77325	-122.46761
1059	4739	NC	FULTON ST	12TH AVE	SE		37.77318	-122.46982
1099	4741	NC	FULTON ST	16TH AVE	SE		37.77295	-122.47419
1292	4740	C	FULTON ST	16TH AVE	NW		37.77305	-122.47492

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1100	4743	NC	FULTON ST	18TH AVE	SW	Y	37.77283	-122.47683
1034	4745	NC	FULTON ST	20TH AVE	SE		37.77275	-122.47846
1294	4746	C	FULTON ST	22ND AVE	NW		37.77276	-122.48134
498	4747	NC	FULTON ST	22ND AVE	SE		37.77266	-122.48061
1035	4748	C	FULTON ST	25TH AVE	NW		37.7726	-122.48452
690	4749	NC	FULTON ST	25TH AVE	SE		37.77251	-122.4838
1036	4751	NC	FULTON ST	28TH AVE	SE		37.77235	-122.48717
630	4753	NC	FULTON ST	30TH AVE	SE		37.77224	-122.48919
1236	4214	NC	FULTON ST	36TH AVE	SE		37.77197	-122.49557
68	4215	NC	FULTON ST	37TH AVE	SE		37.77192	-122.49679
1318	4216	NE	FULTON ST	38TH AVE	NE		37.77198	-122.49798
757	4218	NC	FULTON ST	40TH AVE	SW		37.77179	-122.49991
756	4220	NC	FULTON ST	43RD AVE	SW		37.77159	-122.50363
1237	4222	NC	FULTON ST	46TH AVE	SE		37.77148	-122.50631
1338	4223	NC	FULTON ST	ARGUELLO BLVD	NW		37.774372	-122.458507
249	4224	NC	FULTON ST	ARGUELLO BLVD	SE		37.77429	-122.45781
1037	4228	NC	FULTON ST	LA PLAYA ST	SE		37.77134	-122.50939
84	4229	C	FULTON ST	MASONIC AVE	NE		37.7759	-122.44627
402	4232	NC	FULTON ST	PARK PRESIDIO BLVD	SW		37.77305	-122.47199
758	4231	NC	FULTON ST	PARK PRESIDIO BLVD	NW		37.77319	-122.47218
377	4233	NC	FULTON ST	PARKER AVE	NW		37.775	-122.45324
136	4234	NC	FULTON ST	PARKER AVE (Shrader)	SE		37.77499	-122.45238
568	4255	C	GEARY BLVD	03RD AVE	NE		37.7813	-122.46094
1038	4258	C	GEARY BLVD	06TH AVE	SW		37.78089	-122.4644
97	4257	C	GEARY BLVD	06TH AVE	NE	Y	37.78115	-122.46415
1039	4260	C	GEARY BLVD	09TH AVE	SE		37.78076	-122.46709
994	4259	C	GEARY BLVD	09TH AVE	NW		37.78098	-122.46789
1481	4261	C	GEARY BLVD	12TH AVE	NE		37.78086	-122.47058
530	4262	C	GEARY BLVD	12TH AVE	SW		37.7806	-122.47083
1544	4263	NC	GEARY BLVD	17TH AVE	NE		37.78061	-122.47604
532	4264	C	GEARY BLVD	17TH AVE	SW		37.78035	-122.47629

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
300	4266	C	GEARY BLVD	20TH AVE	SW	Y	37.7802	-122.4795
533	4265	C	GEARY BLVD	20TH AVE	NE	Y	37.78047	-122.47925
1483	4268	C	GEARY BLVD	23RD AVE	SW		37.78006	-122.48271
631	4269	C	GEARY BLVD	25TH AVE	NE	Y	37.78022	-122.48461
93	4270	C	GEARY BLVD	25TH AVE	SW	Y	37.77996	-122.48485
1296	4271	C	GEARY BLVD	28TH AVE	NE		37.78008	-122.48782
759	4272	C	GEARY BLVD	28TH AVE	SW		37.77978	-122.48807
1101	4273	C	GEARY BLVD	30TH AVE	NE		37.77997	-122.48995
554	4274	NC	GEARY BLVD	30TH AVE	SW		37.77971	-122.49021
555	4275	NC	GEARY BLVD	32ND AVE	SE		37.77964	-122.4919
1462	4278	C	GEARY BLVD	33RD AVE	NW	Y	37.77978	-122.49372
301	4279	C	GEARY BLVD	33RD AVE	SW		37.77959	-122.49342
1545	4280	C	GEARY BLVD	36TH AVE	NE		37.77967	-122.4964
995	4281	C	GEARY BLVD	36TH AVE	SW	Y	37.77946	-122.49664
1546	4282	C	GEARY BLVD	39TH AVE	NW		37.77952	-122.50012
996	4283	C	GEARY BLVD	39TH AVE	SW	Y	37.77931	-122.49984
378	4285	NC	GEARY BLVD	42ND AVE	SE	Y	37.77918	-122.50243
125	4287	C	GEARY BLVD	ARGUELLO BLVD	NE	Y	37.7814	-122.45869
126	4288	C	GEARY BLVD	ARGUELLO BLVD	SE	Y	37.78116	-122.45841
608	4289	C	GEARY BLVD	BAKER ST	NW		37.78297	-122.44317
1041	4291	C	GEARY BLVD	COLLINS ST	SE		37.78203	-122.44972
1297	4290	C	GEARY BLVD	COLLINS ST	NE		37.78225	-122.45
185	4293	C	GEARY BLVD	DIVISADERO ST	NE	Y	37.78346	-122.43935
186	4294	C	GEARY BLVD	DIVISADERO ST	SW	Y	37.78316	-122.43961
1547	4296	C	GEARY BLVD	FILLMORE ST	SW		37.78411	-122.43333
272	4295	C	GEARY BLVD	FILLMORE ST	NW	Y	37.78448	-122.43343
1060	4297	C	GEARY BLVD	FRANKLIN ST	NE		37.78557	-122.42289
450	4298	C	GEARY BLVD	GOUGH ST	NW		37.78548	-122.42511
187	4305	C	GEARY BLVD	LAGUNA ST	SW	Y	37.78478	-122.42808
204	4304	C	GEARY BLVD	LAGUNA ST	NE	Y	37.78514	-122.42788
17	4303	C	GEARY BLVD	LEAVENWORTH ST	NE		37.786582	-122.41496

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
23	4754	C	GEARY BLVD	MASONIC AVE	SW		37.78222	-122.44762
1042	4755	NC	GEARY BLVD	PARK PRESIDIO BLVD	NW	Y	37.780731	-122.472378
113	4756	NC	GEARY BLVD	PARK PRESIDIO BLVD	SW	Y	37.780571	-122.472343
31	4757	C	GEARY BLVD	POWELL ST	NW	Y	37.78735	-122.40866
206	4758	C	GEARY BLVD	PRESIDIO AVE	N		37.78251	-122.44676
760	4759	C	GEARY BLVD	PRESIDIO-MASONIC	SW	Y	37.78235	-122.44593
1516	4760	C	GEARY BLVD	SCOTT ST	NE		37.78389	-122.43775
403	4761	NC	GEARY BLVD	SCOTT ST	SE		37.78359	-122.43739
1548	4762	C	GEARY BLVD	SPRUCE ST	NE		37.78186	-122.45307
274	4763	C	GEARY BLVD	SPRUCE ST	SW	Y	37.78159	-122.45326
609	4765	C	GEARY BLVD	ST JOSEPH'S AVE	SE		37.78282	-122.4423
1043	4764	C	GEARY BLVD	STANYAN ST	SW		37.78125	-122.45642
162	4766	C	GEARY BLVD	STOCKTON ST	NE		37.78763	-122.40644
275	4767	C	GEARY BLVD	TAYLOR ST	NW		37.78695	-122.41185
24	4768	C	GEARY BLVD	VAN NESS AVE	N		37.78576	-122.42116
1138	4769	C	GEARY BLVD	WEBSTER ST	SW		37.7848	-122.43097
451	4770	C	GEARY BLVD	WEBSTER ST	NE		37.78442	-122.43139
610	4810	NC	GENEVA AVE	CAYUGA AVE	NE	Y	37.718927	-122.443554
611	7199	NC	GENEVA AVE	CAYUGA AVE	SE	Y	37.718927	-122.443829
437	4886	C	GENEVA AVE	MISSION ST	NE	Y	37.716473	-122.440874
691	1115	C	GENEVA AVE	MISSION ST	SW	Y	37.71641	-122.440748
851	4888	C	GENEVA AVE	MUNICH ST	SW	Y	37.71292	-122.43312
499	4890	C	GENEVA AVE	NAPLES ST	NE	Y	37.71423	-122.436
1102	4892	NC	GENEVA AVE	PARIS ST	NE	Y	37.715705	-122.439294
761	4903	NC	GENEVA AVE	SAN JOSE AVE			37.720565	-122.446608
762	4804	C	GENEVA AVE	SAN JOSE AVE	NW		37.72082	-122.44732
763	4897	C	GENEVA AVE	SAN JOSE AVE	SW		37.72082	-122.44731
820	4790	NC	GONZALEZ DR	FONT BLVD	SE		37.71661	-122.47605
896	4905	C	GOUGH ST	SACRAMENTO ST	NE		37.791041	-122.425771
1170	4915	NC	GRAFTON AVE	PLYMOUTH AVE	SW		37.72001	-122.45627
1319	4920	C	GROVE ST	GOUGH ST	SW		37.777748	-122.423306

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1320	4921	NC	GROVE ST	LAGUNA ST	SE		37.777382	-122.426324
1634	4939	NC	HAHN ST	SUNNYDALE AVE	NE		37.713399	-122.415222
1635	4937	NC	HAHN ST	SUNNYDALE AVE	NW		37.71201	-122.4159
1298	4940	C	HAIGHT ST	BAKER ST	NE		37.77092	-122.44019
998	4942	C	HAIGHT ST	BUCHANAN ST	SW		37.772459	-122.427272
999	4943	NC	HAIGHT ST	BUENA VISTA EAST AVE	SW		37.77077	-122.44055
1000	4944	NC	HAIGHT ST	BUENA VISTA WEST AVE	SE		37.77046	-122.44295
1549	4948	C	HAIGHT ST	COLE ST	NW		37.769598	-122.450782
239	4950	C	HAIGHT ST	DIVISADERO ST	NW	Y	37.77127	-122.43744
240	4951	C	HAIGHT ST	DIVISADERO ST	SE	Y	37.77126	-122.43671
569	4953	C	HAIGHT ST	FILLMORE ST	SE	Y	37.772108	-122.43054
634	4952	C	HAIGHT ST	FILLMORE ST	NW	Y	37.77212	-122.4308
353	4955	NC	HAIGHT ST	LAGUNA ST	NW	Y	37.772744	-122.425872
1550	4961	C	HAIGHT ST	PIERCE ST	SW		37.77162	-122.43385
1212	4963	C	HAIGHT ST	STANYAN ST	SE	Y	37.76917	-122.453075
1551	4962	C	HAIGHT ST	STANYAN ST	NE	Y	37.769279	-122.45305
1378	4968	C	HARRISON ST	04TH ST	NW		37.78061	-122.39999
1104	4970	C	HARRISON ST	06TH ST	NW	Y	37.77712	-122.40442
764	4978	C	HAYES ST	ASHBURY ST	SE		37.773737	-122.447314
955	4977	NC	HAYES ST	ASHBURY ST	NE		37.7738	-122.447567
452	4979	NC	HAYES ST	BAKER ST	NW		37.774573	-122.441501
453	4980	NC	HAYES ST	BAKER ST	SW		37.774509	-122.441259
1003	4982	C	HAYES ST	BRODERICK ST	SW		37.77472	-122.439597
956	4981	C	HAYES ST	BRODERICK ST	NW		37.774783	-122.439837
475	4984	NC	HAYES ST	BUCHANAN ST	SE		37.776244	-122.427555
957	4983	NC	HAYES ST	BUCHANAN ST	NW		37.776261	-122.428274
958	4986	C	HAYES ST	CENTRAL AVE	SW		37.77409	-122.444515
1376	4989	NC	HAYES ST	COLE ST	NE		37.773374	-122.450853
1377	4990	C	HAYES ST	COLE ST	SW		37.773251	-122.451098
501	4991	C	HAYES ST	DIVISADERO ST	NW		37.774992	-122.438181
502	4992	C	HAYES ST	DIVISADERO ST	SE		37.775	-122.437405

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
354	4994	NC	HAYES ST	FILLMORE ST	SE		37.775804	-122.430834
88	4993	NC	HAYES ST	FILLMORE ST	NW		37.775838	-122.431561
504	4995	C	HAYES ST	FRANKLIN ST	NW		37.777099	-122.421667
355	4997	C	HAYES ST	LARKIN ST	NW	Y	37.777709	-122.416852
1213	5000	C	HAYES ST	LYON ST	SW		37.77429	-122.442862
659	5002	C	HAYES ST	MASONIC AVE	SE		37.773946	-122.445679
1005	5004	NC	HAYES ST	PIERCE ST	SE		37.775413	-122.434177
963	5003	NC	HAYES ST	PIERCE ST	NE		37.775472	-122.434443
789	5006	C	HAYES ST	SCOTT ST	SW		37.775146	-122.436253
964	5005	C	HAYES ST	SCOTT ST	NW		37.775211	-122.436458
243	5007	C	HAYES ST	SHRADER ST	NE		37.77317	-122.452502
244	5008	C	HAYES ST	SHRADER ST	SW		37.773042	-122.452756
1006	5009	NC	HAYES ST	STANYAN ST	NE		37.77296	-122.454148
476	5012	NC	HAYES ST	STEINER ST	SE		37.775627	-122.432476
966	5011	NC	HAYES ST	STEINER ST	NW		37.775627	-122.433203
90	5013	NC	HAYES ST	VAN NESS AVE	NW	Y	37.777286	-122.42019
71	5016	NC	HERBST RD	SKYLINE BLVD	SW		37.73161	-122.49932
1352	5017	NC	HERMANN ST	FILLMORE ST	NE		37.770307	-122.429929
1517	5056	C	HOWARD ST	MAIN ST	SW	Y	37.79041	-122.39352
660	5044	NC	HUDSON AVE	BERTHA (Ingalls)	NE		37.732497	-122.379772
806	5068	C	HYDE ST	CLAY ST	NW	Y	37.79287	-122.41784
1171	5071	NC	HYDE ST	FULTON-GROVE	SW		37.77924	-122.4151
1552	5079	C	HYDE ST	MCALLISTER ST	NW	Y	37.78082	-122.41539
853	5083	SW	HYDE ST	PACIFIC AVE	SW		37.79534	-122.41832
821	5089	C	HYDE ST	UNION ST	NW		37.79921	-122.41911
940	5093	C	INDUSTRIAL ST	BAYSHORE-BOUTWELL	S	Y	37.73812	-122.40611
1659	5115	NC	INGERSON AVE	GRIFFITH ST	SE		37.71695	-122.38917
154	5118	NC	IRVING ST	02ND AVE	NE	Y	37.764386	-122.45907
140	5122	C	IRVING ST	07TH AVE	SW	Y	37.764115	-122.464315
141	5123	C	IRVING ST	09TH AVE	NE	Y	37.764106	-122.466165
1484	5124	C	IRVING ST	ARGUELLO BLVD	SW	Y	37.764366	-122.458024

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
404	5147	C	JACKSON ST	FILLMORE ST	NW		37.792449	-122.435082
1140	5166	NC	JACKSON ST	VAN NESS AVE	NW	Y	37.793999	-122.423142
721	5165	C	JACKSON ST	VAN NESS AVE	NE		37.794044	-122.422959
1007	5168	NC	JACKSON ST	WEBSTER ST	NW		37.79266	-122.43339
1554	5183	NC	JESSIE ST	05TH ST	SW		37.782963	-122.40731
1566	5184	C	JONES ST	JEFFERSON-BEACH	NW		37.807248	-122.417366
1565	5184	C	JONES ST	JEFFERSON	SW		37.807248	-122.417366
722	5186	C	JONES ST	POST ST	NW	Y	37.78781	-122.41344
723	5187	C	JONES ST	SUTTER ST	NW	Y	37.78869	-122.41361
899	5190	C	JUDAH ST	06TH AVE	NE		37.76239	-122.46281
857	5191	C	JUDAH ST	07TH AVE	NW		37.76231	-122.46436
858	5192	C	JUDAH ST	07TH AVE	SW		37.7622	-122.46421
1527	5193	NC	JUDAH ST	09TH AVE	NE		37.762165	-122.467119
1528	7084	NC	JUDAH ST	19TH AVE	SW		37.76161	-122.47718
421	7089	NC	JUDAH ST	25TH AVE	SW	Y	37.76134	-122.48355
1529	5225	NC	JUDAH ST	37TH AVE (Sunset)	SW		37.76083	-122.495964
612	7121	NC	JUDAH ST	40TH AVE	SW	Y	37.76077	-122.49937
503	7100	C	JUDAH ST	43RD AVE	SW	Y	37.76048	-122.50284
325	7117	C	JUDAH ST	46TH AVE	SW	Y	37.76035	-122.50605
225	7096	NC	JUDAH ST	SUNSET BLVD	SW	Y	37.76078	-122.49595
1626	5792	NC	JUNIPERO SERRA BLVD	ECALYPTUS (Ocean)	NE		37.71355	-122.471686
823	5136	NC	JUNIPERO SERRA BLVD	FONT BLVD	NW	Y	37.71463	-122.47191
1627	7114	NC	JUNIPERO SERRA BLVD	OCEAN AVE	NW		37.731271	-122.471818
87	7113	NC	JUNIPERO SERRA BLVD	OCEAN AVE	NE	Y	37.731628	-122.471707
1652	5140	C	JUNIPERO SERRA BLVD	PALMETTO	NE	Y	37.71091	-122.47099
635	5141	NC	JUNIPERO SERRA BLVD	SLOAT BLVD	SW	Y	37.73397	-122.47184
824	5227	C	KANSAS ST	23RD ST	SE		37.75442	-122.40249
16	4819	C	KEARNY ST	CALIFORNIA ST	NE	Y	37.79297	-122.4044
724	4820	C	KEARNY ST	CLAY ST	NE	Y	37.7947	-122.40474
163	4821	C	KEARNY ST	GEARY BLVD	NE		37.78823	-122.40341
968	4822	C	KEARNY ST	JACKSON ST	SE		37.79615	-122.40507

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
675	4823	C	KEARNY ST	NO. POINT	NE		37.8072	-122.407165
164	4826	C	KEARNY ST	SUTTER ST	SE		37.78972	-122.40376
380	4843	NC	LA PLAYA ST	CABRILLO ST	SW		37.773214	-122.51006
506	3927	NC	LA PLAYA ST	CABRILLO ST	NE		37.773553	-122.509945
49	7269	NC	LAGUNA HONDA BLVD	LAGUNA HONDA CIR.	NE		37.747836	-122.45879
422	5257	NC	LAGUNA ST	CHESTNUT ST	NW		37.801513	-122.431418
588	5260	NC	LAGUNA ST	HAYES ST	NE		37.776752	-122.42627
165	4847	C	LARKIN ST	GOLDEN GATE AVE	NE	Y	37.7817	-122.41714
1425	4848	NC	LARKIN ST	GROVE ST	NE	Y	37.7791	-122.41658
65	7287	C	LARKIN ST	MCALLISTER ST	SE		37.780453	-122.416946
825	4851	C	LARKIN ST	O'FARRELL ST	SE		37.78507	-122.41782
1044	4852	NC	LAWTON ST	07TH AVE	NW	Y	37.75857	-122.46418
391	4862	C	LEAVENWORTH ST	BUSH ST	SE		37.78922	-122.41529
726	4863	C	LEAVENWORTH ST	CALIFORNIA ST	SE	Y	37.79109	-122.41567
727	4864	C	LEAVENWORTH ST	CLAY ST	SE	Y	37.79295	-122.41604
262	4865	C	LEAVENWORTH ST	GEARY BLVD	SE		37.78643	-122.4147
405	4867	C	LEAVENWORTH ST	O'FARRELL ST	SE	Y	37.7855	-122.41453
728	4869	C	LEAVENWORTH ST	POST ST	SE	Y	37.78736	-122.41488
729	4870	C	LEAVENWORTH ST	SACRAMENTO ST	SE	Y	37.79206	-122.41586
730	4871	C	LEAVENWORTH ST	SUTTER ST	SE	Y	37.788322	-122.415097
1398	5926	NC	LEE (LOOP)	OCEAN AVE	SW		37.72364	-122.45358
790	4873	NC	LEGION OF HONOR DR	PALACE OF HONOR	SE		37.785066	-122.49946
1394	5296	NC	LINCOLN WAY	05TH AVE	NW		37.76617	-122.46257
479	5297	NC	LINCOLN WAY	05TH AVE	SE	Y	37.76605	-122.46181
693	5300	NC	LINCOLN WAY	09TH AVE	NW		37.76599	-122.46674
694	5301	C	LINCOLN WAY	09TH AVE	SE		37.765936	-122.4665
1175	5305	C	LINCOLN WAY	15TH AVE	SW	Y	37.76556	-122.47305
1176	5307	C	LINCOLN WAY	17TH AVE	SW	Y	37.76546	-122.47524
423	5309	NC	LINCOLN WAY	19TH AVE	NW	Y	37.765535	-122.477404
695	5308	C	LINCOLN WAY	19TH AVE	SE		37.7655	-122.47774
1177	5311	C	LINCOLN WAY	21ST AVE	SW	Y	37.7653	-122.47958

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1238	5313	C	LINCOLN WAY	23RD AVE	SW		37.76517	-122.48166
1301	5315	C	LINCOLN WAY	25TH AVE	SE		37.7651	-122.48332
1172	5327	C	LINCOLN WAY	FUNSTON AVE	SW		37.76565	-122.47086
1045	5329	C	LINCOLN WAY	LA PLAYA ST	SW		37.76394	-122.5096
859	5273	C	LOMBARD ST	DIVISADERO ST	NW	Y	37.799061	-122.442769
860	5282	NC	LOMBARD ST	LYON ST	NE	Y	37.79853	-122.44716
900	5285	C	LOMBARD ST	PIERCE ST	NE	Y	37.799462	-122.439306
456	5331	NC	LYON ST	GREENWICH ST	SW	Y	37.79709	-122.44715
14	5335	C	MAIN ST	MISSION ST	NE		37.791982	-122.394964
826	5350	NC	MANSELL ST	SAN BRUNO AVE	NW	Y	37.72159	-122.40149
661	5352	NC	MANSELL ST	SOMERSET ST	NW	Y	37.72062	-122.40521
142	3091	C	MARINA BLVD	LAGUNA ST	SW		37.80513	-122.43221
1485	5638	I	MARKET ST	01ST ST	SW		37.790857	-122.39931
1269	5639	C	MARKET ST	02ND ST	S		37.789397	-122.401299
1269A	5639	K	MARKET ST	02ND ST			37.789397	-122.401299
1268	5641	C	MARKET ST	03RD ST	SE		37.787578	-122.403359
1268A	5641	K	MARKET ST	03RD ST			37.787578	-122.403359
1486	5640	I	MARKET ST	03RD ST.	SW		37.787533	-122.403519
1464	5655	I	MARKET ST	05TH ST	NE		37.784155	-122.407934
1487	5645	I	MARKET ST	05TH ST	SW		37.783843	-122.408195
1265	5646	C	MARKET ST	06TH ST			37.78343	-122.40868
1488	5647	I	MARKET ST	06TH ST	SW		37.781967	-122.410568
1255	5656	C	MARKET ST	07TH ST	NE		37.780669	-122.412354
1255A	5656	K	MARKET ST	07TH ST			37.780669	-122.412354
1264	5648	C	MARKET ST	07TH ST	S		37.78132	-122.41135
1264A	5648	K	MARKET ST	07TH ST	S		37.78132	-122.41135
1265A	5646	K	MARKET ST	07TH ST			37.78343	-122.40868
1489	5679	I	MARKET ST	07TH ST	NE		37.777683	-122.416125
1490	5650	I	MARKET ST	07TH ST	SW	Y	37.780325	-122.412651
1263	5651	C	MARKET ST	08TH ST	S		37.778537	-122.414913
1263A	5651	K	MARKET ST	07TH-08TH ST	S		37.778537	-122.414913

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1262A	5652	K	MARKET ST	8TH-09TH ST	SW		37.777311	-122.416465
1262	5652	C	MARKET ST	8TH-09TH ST	SW		37.777311	-122.416465
1261		K	MARKET ST	10TH ST	NE			
1261A		K	MARKET ST	10TH ST	SE			
1465	5657	I	MARKET ST	BATTERY ST	NE		37.791203	-122.399021
1270	5658	C	MARKET ST	BEALE ST	SE		37.79266	-122.39692
1270A	5658	K	MARKET ST	BEALE ST			37.79266	-122.39692
1411		K	MARKET ST	CASTRO ST			37.4685	-122.1260556
800	5667	C	MARKET ST	CASTRO ST	NW		37.76262	-122.43538
1414	5661	C	MARKET ST	CHURCH ST	NE		37.767829	-122.428628
1414A		K	MARKET ST	CHURCH ST				
1427	5662	I	MARKET ST	CHURCH ST	SE		37.767259	-122.42915
1427A		K	MARKET ST	CHURCH ST				
1415	5668	C	MARKET ST	DOLORES ST	SW		37.76888	-122.427103
1415A		K	MARKET ST	DOLORES ST				
1248	5670	C	MARKET ST	DRUMM ST	NE	Y	37.793494	-122.396127
1248A	5670	K	MARKET ST	DRUMM ST			37.793494	-122.396127
1249	5671	C	MARKET ST	FRONT ST	NE	Y	37.79192	-122.39815
1249A	5671	K	MARKET ST	FRONT ST			37.79192	-122.39815
382	5672	I	MARKET ST	GOUGH ST	NW		37.773269	-122.421768
382A		K	MARKET ST	GOUGH ST				
1252	5674	C	MARKET ST	GRANT AVE	NW	Y	37.78639	-122.40516
1252A	5674	K	MARKET ST	GRANT AVE			37.78639	-122.40516
1267A		K	MARKET ST	GRANT AVE				
1267	5642	C	MARKET ST	GRANT AVE (3rd-4th)	SE	Y	37.78645	-122.40485
1143	5675	I	MARKET ST	GUERRERO ST	SW		37.77057	-122.424971
1143A		K	MARKET ST	GUERRERO ST				
1256	7473	C	MARKET ST	HYDE ST	NE	Y	37.77884	-122.414723
1256A	5676	K	MARKET ST	HYDE ST			37.778871	-122.414623
1491	5676	I	MARKET ST	HYDE ST	NE		37.779105	-122.414379
1466	5677	I	MARKET ST	KEARNY ST	NE		37.78764	-122.40342

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1428	5681	I	MARKET ST	LAGUNA ST	NE		37.770953	-122.424666
1428A		K	MARKET ST	LAGUNA ST				
1257	5680	C	MARKET ST	LARKIN ST	NW		37.77769	-122.41611
1257A	5680	K	MARKET ST	LARKIN ST	NE		37.77769	-122.41611
1492	5682	I	MARKET ST	MAIN ST	SW		37.792984	-122.396627
1254	5683	C	MARKET ST	MASON ST	NW	Y	37.78285	-122.40964
1254A		K	MARKET ST	MASON ST			37.78285	-122.40964
1265	5646	C	MARKET ST	6TH-5TH STS	SE		37.783395	-122.408657
1251	5684	C	MARKET ST	MONTGOMERY ST	NW		37.78849	-122.40248
1251A	5684	K	MARKET ST	MONTGOMERY ST			37.78849	-122.40248
1493	5685	I	MARKET ST	NEW MONTGOMERY ST	SW		37.788613	-122.402163
1341	5686	C	MARKET ST	NOE ST	NW		37.764489	-122.432812
1416	5687	I	MARKET ST	NOE ST	SW		37.763958	-122.433323
1416A		K	MARKET ST	NOE ST				
1258A		K	MARKET ST	POLK ST				
1266	5644	C	MARKET ST	POWELL ST	SE		37.78475	-122.40701
1253	5688	C	MARKET ST	POWELL ST	NE	Y	37.78468	-122.40731
1253A	5688	K	MARKET ST	POWELL ST			37.78468	-122.40731
1266A		K	MARKET ST	POWELL ST				
1073	5690	C	MARKET ST	SANCHEZ ST	NW		37.766185	-122.430707
1412	7123	K	MARKET ST	SANCHEZ ST	SW		37.765632	-122.431216
1413	5691	K	MARKET ST	SANCHEZ ST	NE		37.765625	-122.431219
1250	5689	C	MARKET ST	SANSOME ST	NW		37.78979	-122.40085
1250A	5689	K	MARKET ST	SANSOME ST			37.78979	-122.40085
1271	5693	C	MARKET ST	STEUART ST	SW		37.79426	-122.39491
1271A	5693	K	MARKET ST	STEUART ST			37.79426	-122.39491
1467	5694	I	MARKET ST	STOCKTON ST	NE		37.785963	-122.40558
1468	5695	I	MARKET ST	TAYLOR ST	NE		37.78238	-122.410189
1259	5692	C	MARKET ST	VAN NESS AVE	NW		37.77491	-122.4195
1259	5696	I	MARKET ST	VAN NESS AVE	SW		37.775407	-122.41901
1259A	5692	K	MARKET ST	VAN NESS AVE	SW		37.77491	-122.4195

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
1260A	840	I	MARKET ST	VAN NESS AVE	NE		37.775029	-122.419252
861	5356	NC	MASON ST	BROADWAY	NW		37.79733	-122.41198
863	5363	NC	MASON ST	GREEN ST	SW		37.799	-122.4123
864	5361	C	MASON ST	GREENWICH ST	SW		37.80186	-122.41286
866	5371	NC	MASON ST	VALLEJO ST	NW		37.79826	-122.41214
226	5706	C	MASONIC AVE	FULTON ST	SE		37.77571	-122.44636
25	5710	C	MASONIC AVE	GEARY BLVD	SW		37.78194	-122.44764
867	5709	C	MASONIC AVE	GEARY BLVD	SE		37.78213	-122.44728
1239	5708	C	MASONIC AVE	GOLDEN GATE AVE	SW		37.77728	-122.44687
257	5712	C	MASONIC AVE	HAIGHT ST	NE		37.77031	-122.44542
258	5711	C	MASONIC AVE	HAIGHT ST	SW		37.770125	-122.445441
137	5715	C	MASONIC AVE	HAYES ST	NW		37.77402	-122.44624
870	5717	C	MASONIC AVE	OAK ST	SW		37.77173	-122.44573
188	5719	C	MASONIC AVE	TURK ST	NW		37.77876	-122.44716
871	5718	C	MASONIC AVE	TURK ST	NE		37.77895	-122.44702
766	5385	C	MCALLISTER ST	BAKER ST	SW		37.77731	-122.44185
941	5384	C	MCALLISTER ST	BAKER ST	NE		37.77744	-122.44152
827	5388	NC	MCALLISTER ST	CENTRAL AVE	SE		37.77694	-122.44476
458	5389	C	MCALLISTER ST	DIVISADERO ST	NE		37.77786	-122.43822
459	5390	C	MCALLISTER ST	DIVISADERO ST	SW		37.77773	-122.43851
460	5391	C	MCALLISTER ST	FILLMORE ST	NW		37.77864	-122.43207
461	5392	C	MCALLISTER ST	FILLMORE ST	SE	Y	37.77862	-122.4314
1395	5394	NC	MCALLISTER ST	GOUGH ST	SW		37.77961	-122.42369
383	5395	CPS	MCALLISTER ST	HYDE ST	NW		37.78073	-122.41569
535	5398	C	MCALLISTER ST	LAGUNA ST	NE		37.77933	-122.42671
536	5399	C	MCALLISTER ST	LAGUNA ST	SW		37.77919	-122.42695
791	5397	C	MCALLISTER ST	LARKIN ST	NW		37.78051	-122.41741
901	5401	C	MCALLISTER ST	PIERCE ST	SW		37.77815	-122.43519
970	5400	NC	MCALLISTER ST	PIERCE ST	NE		37.77827	-122.43493
91	5402	CPS	MCALLISTER ST	POLK ST	NW		37.78031	-122.41901
384	5404	NC	MCALLISTER ST	VAN NESS AVE	NW		37.78009	-122.42071

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
697	5405	NC	MCALLISTER ST	VAN NESS AVE	SE		37.78002	-122.41977
1009	5406	C	MCALLISTER ST	WEBSTER ST	NW	Y	37.77885	-122.4305
1215	5407	C	MCALLISTER ST	WEBSTER ST	SE	Y	37.77886	-122.4296
1357	5416	C	MCCOPPIN ST	GOUGH ST	NW		37.77177	-122.42079
1635	5500	NC	MIDDLE POINT RD	INNES AVE	NW		37.73421	-122.37949
1633	5502	NC	MIDDLE POINT RD	WEST POINT RD	SW		37.73648	-122.37945
1634	5503	NC	MIDDLE POINT RD	WEST POINT RD	SE		37.73513	-122.37935
1637	5501	NC	MIDDLE POINT RD	WEST POINT RD	NE		37.736771	-122.37931
166	5528	C	MISSION ST	01ST ST	NE		37.78992	-122.39749
167	5530	C	MISSION ST	02ND ST	NW		37.78787	-122.39985
189	5529	C	MISSION ST	02ND ST	NW		37.78775	-122.40024
1355	5533	C	MISSION ST	04TH ST	SE		37.78464	-122.40393
208	5534	C	MISSION ST	04TH ST	NW	Y	37.78436	-122.40452
13	5535	C	MISSION ST	05TH ST	SW	Y	37.78259	-122.40654
357	5536	C	MISSION ST	05TH ST	NW	Y	37.782725	-122.40664
190	5539	C	MISSION ST	07TH ST	NW		37.77897	-122.41135
406	5540	C	MISSION ST	08TH ST	NW		37.77723	-122.41355
769	5541	C	MISSION ST	08TH ST	SE		37.7777	-122.41273
1469	5542	C	MISSION ST	09TH ST	SE		37.77645	-122.41431
259	5543	C	MISSION ST	09TH ST	NW		37.77594	-122.41518
731	5545	C	MISSION ST	11TH ST	NW		37.77407	-122.41756
770	5546	C	MISSION ST	13TH ST (Duboce)	E		37.77047	-122.41978
1356	5548	C	MISSION ST	14TH ST	SW		37.7678	-122.42002
1494	5549	C	MISSION ST	15TH ST	NE		37.76714	-122.41979
144	5551	C	MISSION ST	16TH ST	NE	Y	37.76554	-122.41964
145	5552	C	MISSION ST	16TH ST	SW	Y	37.76455	-122.41971
302	5553	C	MISSION ST	18TH ST	NE	Y	37.762635	-122.419348
359	5556	C	MISSION ST	18TH ST	SW	Y	37.7598	-122.41925
241	5558	C	MISSION ST	20TH ST	SW	Y	37.75817	-122.41909
242	5557	C	MISSION ST	20TH ST	NE	Y	37.75911	-122.41902
360	5561	C	MISSION ST	22ND ST	NE	Y	37.75582	-122.41871

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
227	5565	C	MISSION ST	24TH ST	NE	Y	37.75273	-122.41841
228	5566	C	MISSION ST	24TH ST	SW		37.751964	-122.418528
119	5572	C	MISSION ST	30TH ST	NW	Y	37.74244	-122.422
327	5574	C	MISSION ST	ACTON ST	NE	Y	37.70889	-122.4522
12	5579	C	MISSION ST	BEALE ST	NW		37.79087	-122.39628
303	5582	C	MISSION ST	BRAZIL AVE	SE	Y	37.72454	-122.43481
770	5546	C	MISSION ST	DUBOCE (13TH)	E		37.77047	-122.41978
127	5593	C	MISSION ST	GENEVA AVE	SW	Y	37.716509	-122.440908
128	5592	C	MISSION ST	GENEVA AVE	NE	Y	37.716455	-122.441149
771	5598	C	MISSION ST	FRANCE-ITALY	W		37.71916	-122.43909
120	5601	C	MISSION ST	LOWELL ST (Naglee)	NE	Y	37.71172	-122.44569
792	5606	C	MISSION ST	MURRAY ST	NE		37.73404	-122.42592
558	5607	C	MISSION ST	NORTON ST	SW	Y	37.72431	-122.43519
636	5609	C	MISSION ST	ONONDAGA AVE	NW	Y	37.72127	-122.43748
304	5610	C	MISSION ST	PERSIA AVE	NE	Y	37.72338	-122.43568
306	5613	C	MISSION ST	RICHLAND ST	SE	Y	37.73591	-122.42442
307	5614	C	MISSION ST	RICHLAND ST	SW	Y	37.73562	-122.4247
305	5615	C	MISSION ST	RUSSIA AVE	SE	Y	37.72145	-122.43715
308	5621	C	MISSION ST	SILVER AVE	SW	Y	37.7285	-122.43165
424	5620	C	MISSION ST	SILVER AVE	SE	Y	37.72862	-122.4313
58	7299	C	MISSION ST	SO. VAN NESS AVE	SE	Y	37.772994	-122.418485
637	5623	C	MISSION ST	SPEAR ST	NW		37.79239	-122.39435
1046	5624	C	MISSION ST	TRUMBULL ST	SE	Y	37.73066	-122.42927
1518	5625	C	MISSION ST	TRUMBULL ST	SW	Y	37.73045	-122.42971
1216	5628	C	MISSION ST	WHITTIER ST	SE	Y	37.71022	-122.44845
1397	5521	NC	MISSOURI ST	20TH ST	NW		37.76013	-122.39633
1240	5423	NC	MONTEREY BLVD	BADEN ST	SW	Y	37.73151	-122.43987
902	5427	NC	MONTEREY BLVD	DETROIT ST	SE	Y	37.73149	-122.44412
1342	5429	C	MONTEREY BLVD	EDNA ST	SW	Y	37.73146	-122.4467
328	5432	C	MONTEREY BLVD	FOERSTER ST	NW	Y	37.73164	-122.44922
329	5433	C	MONTEREY BLVD	FOERSTER ST	SE	Y	37.73145	-122.44857

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
425	5440	C	MONTEREY BLVD	RIDGEWOOD AVE	SE	Y	37.731463	-122.453324
191	5452	NC	MYRA WAY	DALEWOOD WAY	W		37.73681	-122.45386
903	5474	NC	NAPLES ST	ATHENS ST	NE	Y	37.7125	-122.43733
904	5482	NC	NAPLES ST	ROLPH ST	SE	Y	37.71337	-122.4367
1010	5737	NC	NOE ST	29TH ST	SE	Y	37.7433	-122.43104
943	5738	NC	NOE ST	30TH ST	NW	Y	37.74201	-122.43101
1180	5745	C	NORIEGA ST	28TH AVE	NE	Y	37.7539	-122.48598
484	5756	NC	NORIEGA ST	41ST AVE	SW	Y	37.7531	-122.50017
426	5762	NC	NORIEGA ST	46TH AVE	SW	Y	37.75292	-122.50558
168	5765	NC	NORIEGA ST	SUNSET BLVD	SW	Y	37.75331	-122.49544
732	5462	NC	NORTH POINT ST	EMBARCADERO	NW		37.80735	-122.4079
427	5458	C	NORTH POINT ST	HYDE ST	NE		37.8058	-122.42025
428	5459	C	NORTH POINT ST	HYDE ST	SW		37.80565	-122.42049
1074	5460	C	NORTH POINT ST	JONES ST	NW		37.80616	-122.41746
676	5463	C	NORTH POINT ST	KEARNY ST	SW		37.80728	-122.40749
732	5462	NC	NORTH POINT ST	KEARNY (Embarcadero)	NW		37.80735	-122.4079
1110	5467	C	NORTH POINT ST	MASON ST	SE		37.80655	-122.41336
276	5466	C	NORTH POINT ST	MASON ST	NW		37.80656	-122.41424
485	5468	C	NORTH POINT ST	POLK ST	NW		37.80531	-122.424
1111	5471	C	NORTH POINT ST	STOCKTON ST	SW		37.80689	-122.41062
1218	5470	C	NORTH POINT ST	STOCKTON ST	NE		37.80704	-122.41038
1560	5472	C	NORTH POINT ST	VAN NESS AVE	SE	Y	37.805019	-122.425134
1470	5787	I	OCEAN AVE	DORADO TER	NE		37.724957	-122.461059
667	5785	C	OCEAN AVE	GENEVA AVE	SE		37.722947	-122.450866
1381	5785	C	OCEAN AVE	GENEVA AVE	SW	Y	37.722947	-122.450866
1382	5784	C	OCEAN AVE	GENEVA AVE	NW		37.72304	-122.451448
666	5784	C	OCEAN AVE	GENEVA AVE	NE	Y	37.72304	-122.451448
63	5789	C	OCEAN AVE	HAROLD AVE	SW		37.7232	-122.45321
507	5791	NC	OCEAN AVE	HOWTH ST	SE	Y	37.72286	-122.44929
1530	7101	NC	OCEAN AVE	JULES AVE	SW		37.72491	-122.4614
1628	5794	I	OCEAN AVE	LEE ST	SW		37.723522	-122.454022

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
508	5778	I	OCEAN AVE	LEE ST	NE		37.723431	-122.454212
209	5805	C	OCEAN AVE	SAN JOSE ST	SE		37.7229	-122.4444
1630	7106	I	OCEAN AVE	VICTORIA ST	SW		37.72598	-122.46436
1631	5808	I	OCEAN AVE	VICTORIA ST	NW		37.726029	-122.464337
155	5810	C	O'FARRELL ST	STOCKTON-GRANT	S	Y	37.78678	-122.40497
429	5811	C	O'FARRELL ST	HYDE ST	SE		37.78538	-122.41586
59	5812	C	O'FARRELL ST	JONES ST	SE		37.7858	-122.41252
408	5814	C	O'FARRELL ST	LEAVENWORTH ST	SE		37.78561	-122.41421
192	5818	C	O'FARRELL ST	VAN NESS AVE	SW	Y	37.78468	-122.42142
1496	5834	C	O'SHAUGHNESSY BLVD	PORTOLA DR	SE		37.74502	-122.45127
1497	5829	C	O'SHAUGHNESSY BLVD	PORTOLA DR	SW		37.74439	-122.4506
1311	5831	NC	O'SHAUGNESSY (DEL VALE)	DEL VALE (O'Shaugnessy)	SW		37.74111	-122.44594
793	5835	C	OTIS ST	DUBOCE AVE	W		37.77073	-122.42031
1144	5838	C	PACIFIC AVE	HYDE ST	NE		37.79551	-122.41818
486	5851	C	PACIFIC AVE	POLK ST	SE		37.79501	-122.42131
831	5850	C	PACIFIC AVE	POLK ST	NE		37.79507	-122.42146
1146	5856	C	PACIFIC AVE	TAYLOR ST	NE		37.79613	-122.41323
1383	5859	C	PACIFIC AVE	VAN NESS AVE	SE		37.79483	-122.42276
1243	5861	C	PAGE ST	GOUGH ST	SW		37.77403	-122.422524
591	5863	NC	PALOU AVE	03RD ST	NE		37.73401	-122.390791
309	5947	NC	PARK PRESIDIO BLVD	BALBOA ST	SW	Y	37.77648	-122.47214
430	5946	NC	PARK PRESIDIO BLVD	BALBOA ST	NE	Y	37.77725	-122.47194
310	5949	NC	PARK PRESIDIO BLVD	CALIFORNIA ST	NE	Y	37.784586	-122.472493
311	5948	NC	PARK PRESIDIO BLVD	CALIFORNIA ST	SW	Y	37.784363	-122.472711
229	5951	NC	PARK PRESIDIO BLVD	FULTON ST	NW	Y	37.77327	-122.47191
431	5950	NC	PARK PRESIDIO BLVD	FULTON ST	NE	Y	37.773219	-122.471653
230	5952	NC	PARK PRESIDIO BLVD	GEARY BLVD	SW	Y	37.780571	-122.472412
312	5953	NC	PARK PRESIDIO BLVD	GEARY BLVD	NE	Y	37.780776	-122.472217
1112	6086	NC	PARKRIDGE DR	BURNETT AVE	W		37.75041	-122.44578
873	5885	C	PARNASSUS AVE	04TH AVE	NE		37.76274	-122.46071
907	5893	NC	PARNASSUS AVE	SHRADER ST	NE		37.76475	-122.45111

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
908	5896	C	PARNASSUS AVE	STANYAN ST	SW		37.76445	-122.4527
944	5897	C	PARNASSUS AVE	WILLARD ST	NW		37.76433	-122.45459
613	5920	NC	PERSIA AVE	PRAGUE ST	NE	Y	37.71891	-122.42707
509	5923	C	PHELAN AVE	BOOKSTORE (CCSF)	W	Y	37.72385	-122.45243
510	5922	C	PHELAN AVE	OPP BOOKSTORE	E	Y	37.7241	-122.45226
512	5929	NC	PHELAN AVE	OPP SCI BLDG (Cloud Dr)	W		37.72554	-122.45245
511	5928	NC	PHELAN AVE	SCI BLDG (Cloud Dr)	E		37.72602	-122.45228
432	5940	C	PHELPS ST	WILLIAMS AVE	SE		37.73019	-122.39988
333	5974	C	PLYMOUTH AVE	OCEAN AVE	SE	Y	37.72369	-122.45611
334	5975	C	PLYMOUTH AVE	OCEAN AVE	SW	Y	37.72369	-122.45622
1011	6132	NC	POINT LOBOS AVE	48TH AVE	SW		37.77976	-122.50982
1187	6133	C	POINT LOBOS AVE	EL CAMINO DEL MAR	NW		37.7799	-122.50994
638	6134	NC	POINT LOBOS AVE	MERRIE -CLIFF HSE	NW		37.77905	-122.51206
1521	6108	C	POINT LOBOS AVE	MERRIE WAY	W		37.77914	-122.51298
1325	5983	C	POLK ST	BROADWAY	NE		37.79627	-122.42176
231	5984	C	POLK ST	BROADWAY	SW		37.7957	-122.42178
170	5986	C	POLK ST	CALIFORNIA ST	NW		37.79071	-122.42076
277	5985	C	POLK ST	CALIFORNIA ST	NE		37.79084	-122.42067
433	5992	NC	POLK ST	NORTH POINT ST	SW		37.80503	-122.42366
833	5994	C	POLK ST	PACIFIC AVE	NE		37.79527	-122.42156
834	5996	C	POLK ST	PINE ST	SW		37.78938	-122.42051
462	6000	C	POLK ST	SACRAMENTO ST	W		37.7919	-122.421
232	6001	C	POLK ST	SUTTER ST	NE		37.78801	-122.4201
463	6002	C	POLK ST	SUTTER ST	NW		37.78787	-122.42018
233	6004	C	POLK ST	UNION ST	NW		37.79886	-122.42242
699	6012	NC	PORTOLA DR	CLIPPER	S	Y	37.74715	-122.4442
1638	6121	NC	PORTOLA DR	TERESITA BLVD	SW		37.74532	-122.4519
101	6123	C	PORTOLA DR	WOODSIDE AVE	NW	Y	37.74533	-122.45238
1113	6124	C	POST ST	GOUGH ST	SW		37.786123	-122.424982
1244	6018	C	POST ST	LAGUNA ST	SE		37.785774	-122.427675
210	6017	C	POST ST	LEAVENWORTH ST	SE		37.78745	-122.41459

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
673	6020	NC	POST ST	OCTAVIA ST	SW		37.785906	-122.426654
171	6024	C	POST ST	VAN NESS AVE	SE		37.78664	-122.42109
1441	6027	C	POTRERO AVE	16TH ST	SW	Y	37.765701	-122.407646
835	6025	C	POTRERO AVE	16TH ST	NE	Y	37.766343	-122.4082
211	6031	C	POTRERO AVE	18TH ST	SW	Y	37.76164	-122.40729
1471	6119	NC	POTRERO AVE	22ND ST	NE		37.755413	-122.406472
1522	6038	C	POTRERO AVE	24TH ST	NE	Y	37.75336	-122.40624
1561	6039	NC	POTRERO AVE	24TH ST	SW	Y	37.75268	-122.40644
9	6049	C	POWELL ST	CALIFORNIA ST	NE		37.79217	-122.40913
1114	6056	NC	POWELL ST	FRANCISCO ST	SE		37.8048	-122.41168
1358	6055	C	POWELL ST	FRANCISCO ST	1358		37.805	-122.41185
435	6061	NC	POWELL ST	LOMBARD ST	SW		37.80275	-122.41139
1344	6066	C	POWELL ST	NORTH POINT ST	SW		37.80637	-122.41212
112	6089	C	PRESIDIO AVE	CALIFORNIA ST	NW		37.78737	-122.44688
212	6093	C	PRESIDIO AVE	GEARY BLVD	NW		37.78267	-122.44593
1359	6095	NC	PRESIDIO AVE	JACKSON ST	SE		37.79071	-122.4474
615	6099	C	PRESIDIO AVE	SUTTER ST	SW		37.784419	-122.446358
488	6141	NC	QUINTARA ST	19TH AVE	SW	Y	37.74858	-122.47622
1115	6143	NC	QUINTARA ST	22ND AVE	SW		37.74845	-122.47943
1076	6149	NC	QUINTARA ST	27TH AVE	SW		37.74822	-122.48477
836	6172	NC	RANDOLPH ST	ARCH ST	NE	Y	37.714342	-122.466982
1117	6188	NC	RHODE ISLAND ST	15TH ST	SE		37.76727	-122.40278
1245	6197	NC	RHODE ISLAND ST	23RD ST	SW		37.75433	-122.40161
1147	6181	C	RICHARDSON AVE	FRANCISCO ST	NW	Y	37.800408	-122.447447
1360	6182	C	RICHARDSON AVE	FRANCISCO ST	SE		37.800328	-122.446954
1119	6246	NC	RIVERA ST	46TH AVE	SW	Y	37.74543	-122.50504
1080	6247	NC	RIVERA ST	48TH AVE	SE		37.74535	-122.5067
386	6291	NC	SACRAMENTO ST	BUCHANAN ST	NE		37.790316	-122.430617
945	6292	NC	SACRAMENTO ST	BUCHANAN ST	SW		37.790194	-122.430855
1384	6293	C	SACRAMENTO ST	CHERRY ST	S		37.78694	-122.45639
36	6294	C	SACRAMENTO ST	DAVIS ST	NE	Y	37.7945	-122.39761

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
26	6296	C	SACRAMENTO ST	FILLMORE ST	SE		37.789839	-122.433669
336	6295	C	SACRAMENTO ST	FILLMORE ST	NW		37.78984	-122.434336
837	6298	NC	SACRAMENTO ST	GOUGH ST	NW		37.790887	-122.426132
261	6299	C	SACRAMENTO ST	GRANT AVE	NW	Y	37.793411	-122.406306
193	6302	C	SACRAMENTO ST	KEARNY ST	NW		37.793575	-122.404846
616	6309	NC	SACRAMENTO ST	OCTAVIA ST	NE		37.790709	-122.427502
8	6311	C	SACRAMENTO ST	POLK ST	NW		37.791516	-122.421146
363	6316	C	SACRAMENTO ST	STOCKTON ST	NE		37.793236	-122.407591
173	6317	C	SACRAMENTO ST	VAN NESS AVE	NE	Y	37.791378	-122.422286
69	6320	NC	SACRAMENTO ST	WEBSTER ST	SW		37.789987	-122.4325
139	6355	C	SAN BRUNO AVE	BACON ST	NE		37.72797	-122.40367
617	1078	NC	SAN BRUNO AVE	BAYSHORE BLVD	SE		37.71236	-122.402374
537	6361	NC	SAN BRUNO AVE	MANSELL ST	NW	Y	37.72171	-122.40122
539	6360	NC	SAN BRUNO AVE	MANSELL ST	SE	Y	37.72158	-122.40102
1472	6364	NC	SAN BRUNO AVE	SILVER AVE	SE	Y	37.73206	-122.40537
703	6370	NC	SAN BRUNO AVE	WILDE AVE	NE	Y	37.717	-122.39984
514	1015	C	SAN JOSE AVE	GENEVA AVE	SW		37.720613	-122.446577
838	6276	NC	SAN JOSE AVE	OCEAN AVE	SW		37.722933	-122.444894
1190	6281	NC	SAN JOSE AVE	SAN JUAN AVE	NE		37.72715	-122.4412
1582	4788	NC	SAN JOSE ROW	GLEN PARK	E		37.732401	-122.433855
1583	4787	NC	SAN JOSE ROW	GLEN PARK	W		37.732525	-122.433416
1442	6327	C	SANSOME ST	CALIFORNIA ST	NW		37.79318	-122.40122
1081	6330	C	SANSOME ST	LOMBARD ST	SE		37.80393	-122.40325
808	6337	C	SANSOME ST	WASHINGTON ST	NE		37.79606	-122.40166
250	6398	NC	SILVER AVE	CAMBRIDGE ST	NE	Y	37.72911	-122.4194
251	6399	NC	SILVER AVE	CAMBRIDGE ST	SE		37.72904	-122.41901
313	6414	C	SILVER AVE	MISSION ST	NE	Y	37.728776	-122.431102
66	6415	NC	SILVER AVE	MISSION ST	SE		37.72861	-122.43095
27	6422	C	SILVER AVE	SAN BRUNO AVE	NW		37.73237	-122.40599
213	6429	NC	SKYLINE BLVD	ZOO RD	SE	Y	37.72835	-122.50164
387	6435	C	SLOAT BLVD	19TH AVE	NE		37.73479	-122.47458

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
972	6443	NC	SLOAT BLVD	36TH AVE	SW		37.73378	-122.49345
214	6451	NC	SLOAT BLVD	45TH AVE	SE		37.73529	-122.50251
973	6450	C	SLOAT BLVD	45TH AVE	NW		37.73561	-122.50348
1220	6454	C	SLOAT BLVD	CLEARFIELD DR	SW	Y	37.73385	-122.49166
1399	6458	C	SLOAT BLVD	EVERGLADE DR	SW		37.73395	-122.48958
314	6464	C	SLOAT BLVD	WEST PORTAL AVE	NW	Y	37.734736	-122.471607
772	6465	NC	SLOAT BLVD	J SERRA- W PORTAL	SW	Y	37.73462	-122.47187
121	6473	C	SO. VAN NESS AVE	MISSION ST	NE		37.773622	-122.418663
1149	6377	NC	SOUTHERN HEIGHTS AVE	DE HARO ST	NE		37.7581	-122.4008
875	6482	C	STANYAN ST	OAK ST	SE		37.77094	-122.45383
489	6425	C	STARR KING WAY	GOUGH ST	SE		37.7851	-122.42404
794	6491	NC	STEINER ST	UNION ST	SW		37.796627	-122.437137
1272	6501	C	STEUART ST	MARKET ST	SE		37.7944	-122.394596
1272A	6501	K	STEUART ST	MARKET ST			37.7944	-122.394596
645A		K	STEUART ST	MARKET ST				
1498	6500	C	STEUART ST	MISSION ST	NW		37.79336	-122.39349
1562	6510	C	STOCKTON ST	BEACH ST	SE	Y	37.8078	-122.41061
1402	6511	C	STOCKTON ST	SACTO-CLAY	E	Y	37.79379	-122.40778
704	6512	C	STOCKTON ST	COLUMBUS AVE	SE	Y	37.79918	-122.40888
234	6513	C	STOCKTON ST	COLUMBUS AVE (Green)	SW		37.79921	-122.40902
6	6521	C	STOCKTON ST	PACIFIC (Stark)	W	Y	37.797163	-122.408627
1401	6522	C	STOCKTON ST	SACRAMENTO ST	W	Y	37.79353	-122.40786
280	6524	C	STOCKTON ST	SUTTER	NW	Y	37.789632	-122.407095
5	6526	C	STOCKTON ST	WASHINGTON ST	W	Y	37.79536	-122.40822
1653	6571	NC	SUNNYDALE AVE	CORA ST (Tomaso)	SE		37.710203	-122.409612
1636	6577	NC	SUNNYDALE AVE	SANTOS	NE		37.71238	-122.41807
252	6529	NC	SUNSET BLVD	JUDAH ST	NW		37.76101	-122.49588
253	6530	NC	SUNSET BLVD	JUDAH ST	SE		37.76069	-122.49561
174	6539	NC	SUNSET BLVD	NORIEGA ST	NW	Y	37.75356	-122.49534
281	6540	NC	SUNSET BLVD	NORIEGA ST	SE	Y	37.75327	-122.49508
282	6542	NC	SUNSET BLVD	OCEAN AVE	SE		37.73174	-122.49358

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
263	6547	NC	SUNSET BLVD	QUINTARA ST	NE		37.74802	-122.49472
264	6548	NC	SUNSET BLVD	QUINTARA ST	SW		37.74757	-122.49496
254	6555	NC	SUNSET BLVD	TARAVAL ST	NW		37.74236	-122.49458
255	6556	NC	SUNSET BLVD	TARAVAL ST	SE	Y	37.74202	-122.4943
283	6560	NC	SUNSET BLVD	VICENTE ST	SE		37.73836	-122.49405
284	6563	NC	SUNSET BLVD	YORBA ST	SE		37.73481	-122.4938
285	6564	NC	SUNSET BLVD	YORBA ST	SW		37.73466	-122.49404
1305	6585	NC	SUTTER ST	BAKER ST	NE		37.784889	-122.443067
436	6586	C	SUTTER ST	BAKER ST	SW		37.784766	-122.443306
438	6588	C	SUTTER ST	BUCHANAN ST	SE		37.786502	-122.429608
1473	6589	C	SUTTER ST	DIVISADERO ST	NE	Y	37.78531	-122.439732
286	6590	C	SUTTER ST	DIVISADERO ST	SE	Y	37.785259	-122.43943
194	6592	C	SUTTER ST	FILLMORE ST	NE	Y	37.786086	-122.432828
195	6591	C	SUTTER ST	FILLMORE ST	SE	Y	37.786158	-122.433151
1083	6593	C	SUTTER ST	GOUGH ST	NE		37.787207	-122.424924
148	6599	C	SUTTER ST	LAGUNA ST	NW		37.786724	-122.428706
149	6600	C	SUTTER ST	LAGUNA ST	SW		37.786647	-122.428457
515	6598	C	SUTTER ST	LEAVENWORTH ST	NW		37.7884	-122.41555
439	6602	C	SUTTER ST	OCTAVIA ST	NW		37.786933	-122.427062
287	6603	C	SUTTER ST	POLK ST	NW		37.78776	-122.42057
564	6605	C	SUTTER ST	PRESIDIO AVE	SE	Y	37.784453	-122.445776
974	6607	C	SUTTER ST	SCOTT ST	NE		37.78552	-122.438078
975	6608	C	SUTTER ST	SCOTT ST	SW		37.785402	-122.438322
976	6609	C	SUTTER ST	STEINER ST	NE		37.785942	-122.434793
977	6610	C	SUTTER ST	STEINER ST	SW		37.785794	-122.435028
4	6611	C	SUTTER ST	STOCKTON ST	NW		37.78946	-122.40728
466	6612	C	SUTTER ST	TAYLOR ST	NW	Y	37.78881	-122.41226
29	6613	C	SUTTER ST	VAN NESS AVE	NE	Y	37.78763	-122.42154
1531	6619	NC	TARAVAL ST	22ND AVE	SE		37.74289	-122.478426
1532	6620	NC	TARAVAL ST	23RD AVE	NW		37.742872	-122.48045
1533	7124	NC	TARAVAL ST	SUNSET BLVD	SW		37.74213	-122.49463

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
440	6641	NC	TARAVAL ST	SUNSET BLVD	SW	Y	37.742179	-122.494651
1640	6642	C	TAYLOR ST	BAY (CC TERM)	NW		37.80491	-122.4151
1641	6644	C	TAYLOR ST	BAY (CC TERM)	NW		37.80498	-122.41517
46	4772	NC	TEA GARDEN	DE YOUNG MUSEUM	N		37.77056	-122.46884
1361	6657	NC	TENNESSEE ST	18TH ST	SE		37.7629	-122.389664
1151	6686	C	TOLAND ST	JERROLD AVE	SE	Y	37.74391	-122.39884
1499	6691	C	TOWNSEND ST	03RD ST	SE		37.77893	-122.39253
3	6695	C	TOWNSEND ST	04TH ST	SE		37.77695	-122.39504
42	6693	C	TOWNSEND ST	04TH ST	SE		37.77742	-122.39443
594	6706	NC	TRUMBULL ST	CONGDON ST	NW		37.73097	-122.42639
1013	6709	C	TURK ST	ARGUELLO BLVD	SE		37.77715	-122.45818
640	6715	NC	TURK ST	CHABOT TER	SE		37.77801	-122.45119
1523	6718	C	TURK ST	HYDE ST	NW	Y	37.78259	-122.4161
54	6719	C	TURK ST	JONES ST	NW	Y	37.78301	-122.41279
364	6720	C	TURK ST	LARKIN ST	NE	Y	37.78245	-122.41721
774	6725	C	TURK ST	MASONIC AVE	NW		37.77852	-122.44721
1014	6727	NC	TURK ST	PARKER AVE	NE		37.77792	-122.45323
1247	6728	C	TURK ST	PARKER AVE	SW		37.77775	-122.45356
1050	6730	NC	TURK ST	ROSELYN TER	NE		37.77838	-122.44967
1563	6732	NC	TURK ST	STANYAN ST	SE		37.77758	-122.45483
620	6738	NC	ULLOA ST	LENOX WAY	NW		37.741174	-122.46626
86	6744	C	ULLOA ST	WEST PORTAL AVE	SW	Y	37.741023	-122.4661
841	6749	C	UNION ST	COLUMBUS AVE	NE	Y	37.80038	-122.41004
735	6757	C	UNION ST	GOUGH ST	SW		37.79807	-122.42738
1120	6778	NC	UNION ST	PIERCE ST	SW	Y	37.79661	-122.4389
490	6780	C	UNION ST	POLK ST	SW	Y	37.79869	-122.42245
30	6787	C	UNION ST	VAN NESS AVE	SW	Y	37.79848	-122.42418
96	6856	C	VALENCIA ST	14TH ST	NE		37.76839	-122.42212
1363	6874	NC	VALENCIA ST	23RD ST	SE		37.75361	-122.42071
642	6877	C	VALENCIA ST	24TH ST	SW		37.75186	-122.42074
138	6881	C	VALENCIA ST	CESAR CHAVEZ ST	NE		37.748217	-122.420213

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
150	6882	NC	VALENCIA ST	CESAR CHAVEZ ST	SW		37.74764	-122.42033
1501	6885	C	VALENCIA ST	DUNCAN ST	NE		37.74694	-122.42007
978	6798	C	VAN NESS AVE	BROADWAY	NE	Y	37.79608	-122.423331
979	6799	C	VAN NESS AVE	CALIFORNIA ST	NE	Y	37.79076	-122.42225
34	6801	C	VAN NESS AVE	CHESTNUT ST	NW	Y	37.802351	-122.424848
708	6800	C	VAN NESS AVE	CHESTNUT ST	NE	Y	37.80258	-122.42464
72	6803	C	VAN NESS AVE	CLAY ST	NE	Y	37.79245	-122.4226
73	6804	C	VAN NESS AVE	EDDY ST	NE	Y	37.7832	-122.42073
74	6805	C	VAN NESS AVE	EDDY ST	SW	Y	37.7825	-122.42089
236	6808	C	VAN NESS AVE	GEARY BLVD	NW	Y	37.78578	-122.42155
980	6810	C	VAN NESS AVE	GREENWICH ST	SW		37.800281	-122.424436
388	6811	CPS	VAN NESS AVE	GROVE ST	NE	Y	37.77869	-122.41982
441	6813	C	VAN NESS AVE	JACKSON ST	NE	Y	37.794026	-122.422959
491	6814	C	VAN NESS AVE	JACKSON ST	SW	Y	37.793829	-122.423131
216	7030	C	VAN NESS AVE	MARKET ST	NE		37.775216	-122.419378
1	6816	CPS	VAN NESS AVE	MCALLISTER ST	SW	Y	37.779687	-122.420324
89	6815	CPS	VAN NESS AVE	MCALLISTER ST	SE	Y	37.7799	-122.42006
1503	6819	C	VAN NESS AVE	NORTH POINT -BAY	W		37.805028	-122.42534
152	6820	C	VAN NESS AVE	NORTH POINT ST	SW	Y	37.805108	-122.425409
75	6824	C	VAN NESS AVE	O'FARRELL ST	SW	Y	37.78444	-122.42129
76	6823	C	VAN NESS AVE	O'FARRELL ST	NE		37.78503	-122.42109
981	6825	C	VAN NESS AVE	PACIFIC AVE	NW	Y	37.79489	-122.4234
911	6826	C	VAN NESS AVE	PINE ST	NW	Y	37.789509	-122.422304
79	6828	C	VAN NESS AVE	SACRAMENTO ST	NW	Y	37.79137	-122.42268
77	6829	C	VAN NESS AVE	SUTTER ST	NE	Y	37.78783	-122.42166
78	6830	C	VAN NESS AVE	SUTTER ST	SW	Y	37.787396	-122.421838
2	6832	C	VAN NESS AVE	UNION ST	NW	Y	37.798621	-122.424104
736	6834	C	VAN NESS AVE	VALLEJO ST	SW	Y	37.79641	-122.4237
799	6835	NC	VICENTE ST	30TH AVE	SE		37.73875	-122.48682
339	6847	C	VISITACION AVE	BAYSHORE BLVD	NW		37.71058	-122.4047
541	6850	NC	VISITACION AVE	RUTLAND ST	NE		37.71144	-122.40777

SHELTER_#	STOP_ID	TAG_TXT	ON_STREET	AT_STREET	Corner	Nextbus	LATITUDE	LONGITUDE
567	6851	NC	VISITACION AVE	RUTLAND ST	SW	Y	37.71144	-122.40807
595	6854	NC	VISITACION AVE	SCHWERIN ST	NE		37.7122	-122.41051
1581	7057	NC	VISITACION AVE	TERM. (VV Middle School)	SE		37.71612	-122.41374
1152	6915	NC	WASHINGTON ST	BUCHANAN ST	SW		37.79194	-122.43121
1153	6917	NC	WASHINGTON ST	FRANKLIN ST	SW		37.79281	-122.42462
1154	6918	NC	WASHINGTON ST	GOUGH ST	SW		37.79258	-122.42626
1155	6923	NC	WASHINGTON ST	LAGUNA ST	SE		37.7922	-122.42921
946	6921	NC	WASHINGTON ST	LARKIN ST	SW		37.79341	-122.4198
196	6925	NC	WASHINGTON ST	MASON ST	SW		37.79448	-122.41148
1156	6931	NC	WASHINGTON ST	WEBSTER ST	SW		37.79175	-122.43286
669	6932	C	WAWONA ST	46TH AVE	SW	Y	37.736125	-122.504351
670	7205	NC	WEST PORTAL AVE	ST FRANCIS	NE		37.734914	-122.4714
643	6502	NC	WEST PORTAL AVE	ST FRANCIS (Sloat)	NW		37.73502	-122.471252
645	6954	NC	WINSTON DR	LAKE MERCED BLVD	NE		37.72712	-122.48337
709	6934	NC	WOODSIDE AVE	HERNANDEZ AVE	NE		37.74638	-122.45535
1121	6938	C	WOODSIDE AVE	PORTOLA DR	SW	Y	37.74558	-122.45239
672	6937	NC	WOODSIDE AVE	PORTOLA DR	NW	Y	37.74572	-122.45238

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appendix **thirty-two**

Metro Subway Tunnel Crossovers, Passage Ways and Emergency Exits

for reference only

Metro Subway Tunnel Crossover, Passages and Emergency Exits: General Notes

Location Markers are installed throughout the Metro subway. These three-digit markers are located on the upper walls of the subway. The numbers are painted white on a brown background. The subway tracks are identified as:

- TR = Track Right for Mainline Inbound (IB) – West Portal to Ferry Portal
- TL = Track Left for Mainline Outbound (OB) – Ferry Portal to West Portal
- DR = Duboce Right for Duboce Portal Inbound to Mainline Inbound
- DL = Duboce Left for Mainline Outbound to Duboce Portal Outbound

The numbering scheme for the location markers denotes a reference to distance throughout the subway, in 200-foot increments, from each station, or portal in the case of Ferry Portal. The first digit refers to the station number, and the second and third digits indicate the number of feet, in hundreds, west of the next station to the east. If the last digit is an even number, it refers to the IB (or TR) track; odd last digits refer to the OB (or TL) track. (A convenient way to remember this is that OB = ODD.) These numbers do not correspond to any surface locations. Station numbers (the first digit) are as follows:

Station #	Station Names
0	Ferry Portal
1	Embarcadero
2	Montgomery
3	Powell
4	Civic Center
5	Van Ness
6	Church
7	Castro
8	Forest Hill

Note: West Portal does not have a designation number because it is at the western end of the subway.

Examples:

012 = 1,200 feet west of Ferry Portal on TR

514 = 1,400 feet west of Van Ness Station on TR

713 = 1,300 feet west of Castro Station on TL

Tunnel Crossovers and Passages

Crossover passages provide access in the subway between adjacent or nearby tracks that are separated by a wall or other barrier. Crossover passages are located throughout the subway. See the tables below for a list of the locations of all crossover passages.

Many of the crossover passages have doors. The doors may slide or swing open and shut.

The crossover passages may consist of:

- A doorway or opening in a wall that has no door
- A doorway with a single door
- A hallway with a door at each end
- A stairway between different track levels with a door at each end

Crossover passages may be used as part of an emergency exit or evacuation route. They are also used for access by various maintenance personnel.

Location Markers	Description of Passage & Location
TR = between 010/012 TL = at 011	Hallway with doors at each end – also provides access to emergency stairway to surface and Justin Herman Vent Structure 1100 feet west of Ferry Portal 1000 feet east of Embarcadero Station
TR = at 014 TL = between 013/015	Hallway with doors at each end 1400 feet west of Ferry Portal 300 feet west of Justin Herman Vent Structure 700 feet east of Embarcadero Station
TR = at 108 TL = near 107	Hallway with doors at each end – also provides access to emergency stairway to concourse level of Montgomery Station 800 feet west of Embarcadero Station 100 feet east of Montgomery Station
TR = between 206/208 TL = at 207	Hallway with doors at each end 700 feet west of Montgomery Station 800 feet east of Powell Station
TR = at 214 TL = near 213	Hallway with doors at each end – also provides access to emergency stairway to concourse level of Powell Station 800 feet west of Montgomery Station 100 feet east of Powell Station
TR = between 308/310 TL = near 309	Hallway with doors at each end 900 feet west of Powell Station 900 feet east of Civic Center Station
TR = at 408 TL = between 407/409	Hallway with doors at each end 800 feet west of Civic Center Station 800 feet east of Van Ness Station
TR = between 506/508 TL = near 507	Hallway with doors at each end 700 feet west of Van Ness Station 3,000 feet east of Church Station

Location Markers	Description of Passage & Location
TR = between 512/514 TL = near 513	Hallway with doors at each end 1,300 feet west of Van Ness Station 2,300 feet east of Church Station
TR = near 526 TL = at 525	Stairway with doors at each end, between track right (lower level) about 50 feet west of the end of dividing wall at Duboce Junction, and track left (upper level) located at Duboce Junction – both doors located on south side of mainline tracks 2,500 feet west of Van Ness Station 1,200 feet east of Church Station
DR and DL	Stairway with doors at each end, between Duboce track right (lower level) near Signal D-4, and Duboce track left (upper level) near Signal D-2 – both doors located on south side tracks about 20 feet inside of the Duboce Portals right and left – also connects with emergency stairway to surface at the Mint Yard
TR = near 534 TL = at 535	Sliding door between tracks 3,500 feet west of Van Ness Station 200 feet east of Church Station
TR = near 536 TL = at 537	Sliding door between tracks 3700 feet west of Van Ness Station <100 feet east of Church Station
TR = near 602 TL = near 601	Sliding door between tracks 100 feet west of Church Station 1,600 feet east of Castro Station
TR = near 604 TL = near 605	Sliding door between tracks 500 feet west of Church Station 1,200 feet east of Castro Station
TR = near 608 TL = near 607	Sliding door between tracks 700 feet west of Church Station 1,000 feet east of Castro Station

Location Markers	Description of Passage & Location
TR = near 610 TL = near 611	Sliding door between tracks 1,000 feet west of Church Station 700 feet east of Castro Station
TR = near 614 TL = near 613	Open doorway between tracks 1,300 feet west of Church Station 400 feet east of Castro Station
TR = near 616 TL = at 617	Sliding door between tracks 1700 feet west of Church Station <100 feet east of Castro Station
From marker 706 on TR to marker 717 on TL	From the west end of old Eureka Station to 1,700 feet west of Castro Station there is a dividing wall between the tracks with 21 open doorways serving as cross passages between track right and track left

Tunnel Emergency Exits

Emergency exits and emergency egress routes are located throughout the subway. See the tables below for a list of the locations of all emergency exits and directions for emergency egress.

Location	Egress Locations and Directions
Ferry Portal and Muni Metro Turnback (MMT) Area	**a) From the MMT center pocket area exit via catwalks on both track right and track left through Ferry Portal and up the ramp to surface at Embarcadero and Folsom Streets.** **b) From the MMT far pocket area exit via catwalk towards the back wall, up the stairway, and through the emergency exit door, and then up the ramp to surface at Embarcadero and Folsom Streets.** **c) From MMT near pocket area or tunnel between Embarcadero Station and the MMT, exit through yellow emergency cross passage doors, (1,100 feet from Ferry Portal or 900 feet from Embarcadero), on track right near switch T7 or on track left near switch T5A, then take stairway through Justin Herman Vent Structure to surface exit on Don Chee Way near Steuart Street.**
Embarcadero Station	**Exit from Muni track level by way of either east or west escalators to concourse level. There are no stairs between the platform and mezzanine levels.** **Upon reaching the concourse level, exit paid area through nearest faregate or emergency gate and proceed up any of the six stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Drumm/California (NE corner)** **- Market & Spear (SW corner)** **- Market & Main (SW corner)** **- Market & Davis (NE corner)** **- Market & Beale (SW corner)** **- Market & Pine (NW corner)** **There is no emergency access to the street other than that provided at station entrances.**

Location	Egress Locations and Directions
Tunnel between Embarcadero & Montgomery Stations	**a) From the outbound track (track left) near marker 108 exit through the emergency door into the cross passage.** **OR** **b) From the inbound track (track right) near marker 107 exit through the emergency door into the cross passage.** **THEN** **From the cross passage proceed up the emergency stairway to the concourse level of Montgomery Station and then exit the station via the nearest of seven stairways to Market Street. See below for the stairway locations.**
Montgomery Station	**Exit Muni track level by way of either east or west stairways to concourse level. Upon reaching the concourse level, exit paid area through nearest faregate or emergency gate.** **Proceed up the nearest of the seven stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Sansome & Sutter (NW corner)** **- Market & Sutter (NW corner)** **- Market between 1st & 2nd (south side)** **- Market & 2nd (SE corner)** **- Market & Montgomery (NE corner)** **- Market & Montgomery/Post (NW corner)** **- Market & New Montgomery (SW corner)** **There is no emergency access to the street other than that provided at station entrances.**

Location	Egress Locations and Directions
Tunnel between Montgomery & Powell Stations	**a) From the outbound track (track left) near marker 213 exit through the emergency door into the cross passage. OR** **b) From the inbound track (track right) near marker 214 exit through |the emergency door into the cross passage. THEN** **From the cross passage proceed up the emergency stairway to the concourse level of Powell Station and then exit the station via the nearest of eight stairways to Market Street. See below for the stairway locations.**
Powell Station	**Exit Muni track level by way of either east or west stairways to concourse level. Upon reaching the concourse level, exit paid area through nearest faregate or emergency gate.** **Proceed through any of the eight exits and up the stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Stockton (NE corner)** **- Market & 4th (SE corner)** **- Stockton & Ellis (NW corner)** **- Market & 4th (SW corner)** **- Market & Stockton (NW corner)** **- Halladie Plaza at concourse level with:** **- escalators to Market & Powell (NW corner)** **- stairs to Cyril Magnin & Eddy (NE corner)** **- stairs to Cyril Magnin & Eddy (SW corner)** **- stairs to Market & Cyril Magnin (NW corner)** **- Market & 5th (SE corner)** **- Market & 5th (SW corner)** **There is no emergency access to the street other than that provided at station entrances.**

Location	Egress Locations and Directions
Civic Center Station	**Exit Muni track level by way of either east or west stairways to concourse level.** **Upon reaching the concourse level, exit paid area through nearest faregate or emergency gate and proceed up any of the eight stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Charles Brenham (NW corner)** **- Market & 7th (SW corner** **- United Nations Plaza (north side of Market)** **- Market between 7th & 8th (south side)** **- Market & Hyde (NE corner)** **- Market & 8th (SE corner)** **- Grove & Market (NW corner)** **- Market & 8th (SW corner)** **There is no emergency access to the street other than that provided at station entrances.**
Van Ness Station	**Exit Muni track level by way of either east or west stairways to mezzanine level.** **Upon reaching the mezzanine level, exit paid area through nearest faregate or emergency gate and proceed up any of the four stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Van Ness (NE corner)** **- Market & South Van Ness/11th (SE corner)** **- Market & Van Ness (NW corner)** **- Market & South Van Ness (SW corner)** **There is no emergency access to the street other than that provided at station entrances.**

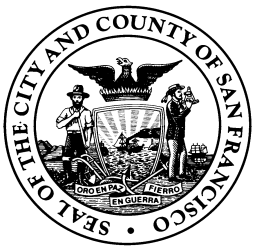
Location	Egress Locations and Directions
Duboce *Junction* Area – Track Left (Upper level)	**a) Proceed via catwalk to Duboce Portal, then exit through Duboce Portal via trackway (DL) to surface at Duboce and Church.** **OR** **b) Proceed via catwalk to Duboce Portal, go through emergency door, take cross passage stairway DOWN to track right and then exit Duboce Portal via trackway (DR) to surface at Duboce and Church.** **OR** **c) Proceed via catwalk to Duboce Portal, go through emergency door, take emergency stairway UP and then exit through emergency hatch to surface inside the Mint Yard and go out emergency gate onto the Duboce Bikeway near Duboce and Market.**
Duboce *Junction* Area – Track Right (Lower level)	**a) Proceed via catwalk to Duboce Portal and exit Duboce Portal via trackway (DR) to surface at Duboce and Church.** **OR** **b) Proceed via catwalk to Duboce Portal, go through emergency door, take cross passage stairway UP one level, go out through emergency door and then exit Duboce Portal via trackway (DL) to surface at Duboce and Church.** **OR** **c) Proceed via catwalk to Duboce Portal, go through emergency door, take cross passage stairway UP two levels, and exit through emergency hatch to surface inside the Mint Yard and go out emergency gate onto the Duboce Bikeway near Duboce and Market.**

Location	Egress Locations and Directions
Duboce *Portal* Area – Track Left (Upper level)	**a) Exit Duboce Portal via trackway (DL) to surface at Duboce and Church.** **OR** **b) Proceed through emergency door, take cross passage stairway DOWN to track right, and then exit Duboce Portal via trackway (DR) to surface at Duboce and Church.** **OR** **c) Proceed through emergency door, take emergency stairway UP, then exit through emergency hatch to surface inside the Mint Yard and go out emergency gate onto the Duboce Bikeway near Duboce and Market.**
Duboce *Portal* Area – Track Right (Lower level)	**a) Exit Duboce Portal via trackway (DR) to surface at Duboce and Church.** **OR** **b) Proceed through emergency door, take cross passage stairway UP one level, go out through emergency door and then exit Duboce Portal via trackway (DL) to surface at Duboce and Church.** **OR** **c) Proceed through emergency door, take cross passage stairway UP two levels, and exit through emergency hatch to surface inside the Mint Yard and go out emergency gate onto the Duboce Bikeway near Duboce and Market.**

Location	Egress Locations and Directions
Church Station	**a) Exit from outbound or inbound platforms (track left or track right) by way of main stairway in center of station up to mezzanine level and then exit paid area through nearest faregate or emergency gate.** **OR** **b) Exit from platform level by way of emergency exit doors located at far east end of outbound platform and about 100 feet from east end of inbound platform, and then go up emergency stairway to mezzanine level.** **THEN** **From the mezzanine level proceed up either of the two stairways to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Church (NW corner)** **- Market & Church (SW corner)** **There is no emergency access to the street other than that provided at station entrances.**

Location	Egress Locations and Directions
Castro Station	**a) Exit from the east end of the outbound platform (track left) through emergency exit gate and proceed up stairway directly to surface and exit through emergency hatch in sidewalk on Market at Castro (NE corner).** **OR** **b) Exit from the east end of the inbound platform (track right) through emergency exit gate and proceed up stairway directly to surface and exit through emergency hatch in sidewalk on Market at Castro/17th (SE corner).** **OR** **c) Exit from outbound or inbound platforms (track left or track right) by way of main stairway in center of station up to mezzanine level and then exit paid area through nearest faregate or emergency gate.** **From the mezzanine level proceed out of south side of station into Harvey Milk Plaza and then up stairway to Market Street, OR from north side of mezzanine proceed directly up stairway to Market Street.** **Exits/entrances on the surface are located as follows:** **- Market & Castro (SW corner)** **- Market & Castro (NW corner)**
Eureka Portal and Eureka Station Area	**a) Exit through Eureka Portal from either track left or track right up trackway to surface at Market and Collingwood.** **WARNING: The Eureka Portal exits are normally blocked by locked gates and are usually not available for use as emergency egress.** **OR** **b) Exit from the west end of the old Eureka Station outbound platform (track left) up stairway directly to surface and exit through emergency hatch in sidewalk on Market at Eureka (NE corner).** **OR** **c) Exit from the west end of the old Eureka Station inbound platform (track right) up stairway directly to surface and exit through emergency hatch in sidewalk on Market at Eureka (SE corner).**

Location	Egress Locations and Directions
Forest Hill Station	**a) Exit from outbound or inbound platforms (track left or track right) by way of main stairway in center of station up to station lobby, (which is at surface level), then exit paid area through nearest faregate or emergency gate, and then exit station through the main front doors, which open onto Laguna Honda Blvd mid-block between Dewey and Plaza.** **OR** **b) Exit from the east end of both the outbound and inbound platforms, (track left or track right), through emergency exit doors and proceed up stairway directly to surface and exit through emergency door that opens onto sidewalk across the street from the entrance to the station on Laguna Honda Blvd.**
West Portal Station	**Exit through the fare gates or emergency gates from the west end of both the outbound and inbound platforms, (track left and track right), directly onto the sidewalk at West Portal and Ulloa.**



appendix **thirty-three**

Subcontractor Form

SUBCONTRACTORS

The Proposer submits the following information as to every subcontractor who will be performing work in excess of 1/2 of 1% of the contract amount that the Proposer intends to employ if awarded the contract. At the time of submitting the proposal, Subcontractors must possess appropriate licenses covering subcontract work they will be performing.

***Proposers to attach additional sheets if necessary

Name and Address of Subcontractor, and Location of Mill or Shop	Description of Work, Reference to Contract Items	Price or Prices Under Subcontract	California License Number, Classes, Issue and Expiration dates	SF Business Tax Registration Certificate No.

appendix **thirty-four**

City Build/First Source Referral Program

appendix to be issued as an addendum at a future date